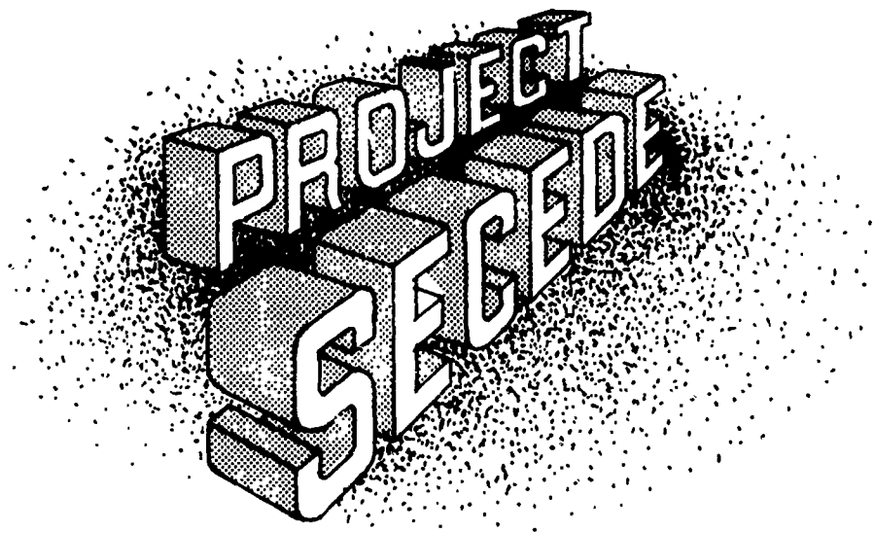
AD 744833

RADC-TR-72-122
Final Technical Report
January 1972

Prepared By
Rome Air Development Center
Air Force Systems Command
Griffiss Air Force Base, New York 13440



A COMPENDIUM OF OPTICAL INTERFEROMETER RESULTS ON SECEDE II

General Electric

Sponsored by
Defense Advanced Research Projects Agency
ARPA Order No. 1057

Approved for public release;
distribution unlimited.

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expresced or implied, of the Defense Advanced Research Projects Agency or the U. S. Government.

61

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author)	2a. REPORT SECURITY CLASSIFICATION
General Electric Company Space Sciences Laboratory P.O. Box 8555 Philadelphia, PA 19101	UNCLASSIFIED 2b. GROUP

3. REPORT TITLE

"A Compendium of Optical Interferometer Results on SECEDE II"

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

FINAL REPORT

5. AUTHOR(S) (First name, middle initial, last name)

Irwin M. Pikus
Gerald Liebling

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
January 31, 1972	59	3

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
F30602-71-C-0064 b. PROJECT NO.	
c. Program Code Number 1E20	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)
d. ARPA Order Number 1057	RADC-TR-72-122

10. DISTRIBUTION STATEMENT

Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
Monitored by R. Schneible T. Pitts RADC, Griffiss Air Force Base, N.Y. 13440	Advanced Research Projects Agency Washington, D. C. 20301

13. ABSTRACT

Project Secede is an ARPA program aimed at solving certain defense related problems through the study of chemical releases in the ionosphere. The chemical of primary interest has been barium. The aspects of the release which are of most interest include the growth of the cloud and the evolution of its striated structure. Several test series of releases have been conducted the latest of which was Secede II.

The present report concerns data obtained during Secede II by an optical interferometer built and operated by M. A. biondi, R. Hake, and D. Sipler of the University of Pittsburgh with the support of R. Lambert and the General Electric Space Sciences Laboratory. The report consists of a number of data volumes and this one summary textual volume. Only the summary volume will receive general circulation; the data volumes will be distributed to only a few users and additional copies may be requested from the contracting officer. Data volumes exist for events Spruce, Olive, Redwood, and Plum.

Interferometer data on events Spruce, Olive, Redwood and Plum has been reduced and photographs of representative IO records on Spruce have been made IO records of other events are absent presumably because of non-optimum adjustment of the system during those events. The interferometer data is presented in detail in the Event Data Books published separately while the IO records on Spruce are reproduced in this volume.

Details of illustrations in this document may be better studied on microfiche

DD FORM 1 NOV 68 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
SECEDE II						
INTERFEROMETER						
BARIUM CLOUDS						
DIGITAL DATA REDUCTION						
IMAGE ORTHICON CLOUD RECORDS						
GNOMONIC PROJECTIONS						

A COMPENDIUM OF OPTICAL INTERFEROMETER RESULTS ON SECEDE II

I. M. Pikus
G. Liebling

Contractor: General Electric
Contract Number: F30602-71-C-0064
Effective Date of Contract: May 1970
Contract Expiration Date: January 1972
Amount of Contract: $252,979.00
Program Code Number: 2E20

Principal Investigator: Dr. I. M. Pikus
Phone: 215 962-2908

Project Engineer: Vincent J. Coyne
Phone: 315 330-3107

Contract Engineer: Richard A. Schneible
Phone: 315 330-3451

Approved for public release;
distribution unlimited.

This research was supported by the Defense Advanced Research Projects Agency of the Department of Defense and was monitored by Richard A. Schneible, RADC (OCSE), GAFB, NY 13440 under Contract F30602-71-C-0064.

PUBLICATION REVIEW

This technical report has been reviewed and is approved.

Everett O. Coyne
RADC Project Engineer

Richard Schneible
RADC Contract Engineer

I. BACKGROUND AND PERSPECTIVES

Project Secede is an ARPA program aimed at solving certain defense related problems through the study of chemical releases in the ionosphere. The chemical of primary interest has been barium. The aspects of the release which are of most interest include the growth of the cloud and the evolution of its striated structure. Several test series of releases have been conducted the latest of which was Secede II.

The present report concerns data obtained during Secede II by an optical interferometer built and operated by M. A. Biondi, R. Hake, and D. Sipler of the University of Pittsburgh with the support of R. Lambert and the General Electric Space Sciences Laboratory. The report consists of a number of data volumes and this one summary textual volume. Only the summary volume will receive general circulation; the data volumes will be distributed to only a few users and additional copies may be requested from the contracting officer. Data volumes exist for events Spruce, Olive, Redwood, and Plum.

Briefly, the series was held in the vicinity of Eglin Air Force Base, Florida, during January and early February 1971. The test matrix is shown in Table 1.

TABLE 1

SECEDE II TEST MATRIX (U)

EVENT	DATE	RELEASE TIME (CST)	ALTITUDE (km)	PAYLOAD WEIGHT (kg)
NUTMEG	16 Jan 71	1734:40	150	48
OLIVE	29 Jan 71	1753:57	185	352
PLUM	20 Jan 71	1747:06	185	48
QUINCE	2 Feb 71	1034:06	185	48
REDWOOD	26 Jan 71	1752:08	250	48
SPRUCE	1 Feb 71	1752:04	185	48

The instrument complex has been described in detail in Reference 1 and 2, but the salient characteristics are summarized as follows. Instrumentation consisted of three major devices: a two channel Fabry-Perot Interferometer (FP); a filter photometer; and an image orthicon system. The FP was used to obtain spectral line profiles by scanning wavelength (by changing driving gas pressure) while viewing in a fixed direction and to obtain spatial intensity profiles by scanning the cloud while maintaining a constant wavelength. The filter photometer was used to obtain light intensity over a relatively wide field of view integrated over an entire spectral line. Normally the photometer viewed the 4934A feature but had the capability of viewing the 5535, 6111, and 6142 lines as well. The IO system is described in Reference 2.

II. DATA REDUCTION

Interferometer data on events Spruce, Olive, Redwood and Plum has been reduced and photographs of representative IO records on Spruce have been made. IO records of other events are absent presumably because of non-optimum adjustment of the system during those events. The interferometer data is presented in detail in the Event Data Books published separately while the IO records on Spruce are reproduced in the next section of this volume.

The first element of the reduced interferometer data is a plot of azimuth and elevation for each scan. Instead of merely presenting a rectilinear presentation it was decided that the pointing information could better be arranged as a scan line which could be laid over a photograph of the cloud so to facilitate identification of structural features and comparison of digital records and densitometric results. A photograph is a representation of the projection of a 3-d scene on the plane (assuming no distortion) normal to the optical axis of the system. To compare the interferometer scan line with such a photograph it is necessary: a) to have had the camera and interferometer sufficiently close to each other that they viewed the cloud from nearly the same aspect and b) to present the scan line as a projection upon the same plane that is represented by the photograph. To accomplish this the scan line is presented in the gnomonic projection.

The gnomonic projection is the projection of a sphere upon a plane tangent to the sphere at a given point, as seen from the center of the sphere. An important property of this projection is the fact that all great circles are represented by straight lines.

In Figure 1 let the circle represent the meridional plane of the sphere (i. e. constant azimuth) on which the projection plane is tangent. Let the radius of the sphere be R. The point A, located an angular distance α from the radius vector to the projection plane. A' is located at a distance $\rho = R \tan \alpha$ from the point of tangency P. All points located at an angle of α from the radius $\overline{OP}$ project onto a circle of radius $R \tan \alpha$ on the projection plane, as shown in Figure 2. In that figure the Y axis is taken to be the projection of the meridian through the point of tangency while the X axis is the projection of the orthogonal great circle going through the same point. If we let

Φ = elevation of the mount (with the equator identical with horizon)

λ = azimuth measured from the meridian of tangency.

and Φ_0 = the elevation of the point of tangency

Then a point located at (Φ, λ) on the sphere will be mapped into a point located at (x, y) on the plane of Figure 2 where

$$\frac{X}{R} = \frac{\sin \lambda \cos \Phi}{\sin \Phi_0 \sin \Phi + \cos \Phi_0 \cos \lambda \cos \Phi}$$

and

$$\frac{Y}{R} = \frac{\cos \Phi_0 \sin \Phi - \sin \Phi_0 \cos \lambda \cos \Phi}{\sin \Phi \sin \Phi_0 + \cos \Phi \cos \Phi_0 \cos \lambda}$$

Using these equations, points on a sphere can be mapped onto the plane tangent at elevation Φ_0 and azimuth $\lambda = 0$. Hence the series of points, specified by their azimuth and elevation values, at which optical data exist can be plotted on a plane representing the plane of tangency.

To compare the projected scan line with a photograph of the cloud it is necessary to know the azimuth and elevation of the point of tangency and the scale size

(i. e. the value of R in the above equations). From this information cloud photographs should be able to be reproduced which can be directly compared with the scan lines.

It will be noticed in the data books that the configuration of the scan grid varies with reference elevation. This preserves the scale factor, which bears a direct relationship to the magnification factor, so that a constant magnification can be achieved. That is, a given azimuthal interval will take less linear space at higher elevations than at low.

The scan line is presented at several scale factors, depending on the angular extent of the scan. The grid sizes used are: 6^{o} azimuth x 6^{o} elevation; 10^{o} x 10^{o}, and 14^{o} x 14^{o}. As plotted, the scale factors are:

6 x 6 grid; 1" = 1^{o} subtense

10 x 10 grid; 1" = 1.67 subtense

14 x 14 grid; 1" = 2.33 subtense

III. IMAGE ORTHICON RECORDS

Photographs of 18 frames of the IO record on event Spruce follow. Although the quality of the originals has been degraded through the reproduction process, the striated structure of the developed cloud is apparent. The first line of the data block contains the time in hours, minutes, and seconds. These records can be compared with the digital records on Spruce although no attempt has been made for this summary report to render the scale accurately. Densitometric studies on these photographs are very difficult because of the non-linear transfer function involved in their reproduction. However, point values of intensity can be deduced from intensities on the video tape.

IV. FORM OF THE REDUCED DATA

As a sample, the reduced data from record 101 of event Spruce is included as Appendix 2. Although in the appendix the several frames of the record are separate sheets, the data books contain each record as an integral folded sheet which can be removed for detailed work. This particular record is shown as representative of many of the features of the reduced data which may be of interest.

First, the scan line is plotted on a $6^{o} \times 6^{o}$ grid. On this record the scan line extends beyond the acceptable limits for the $6^{o} \times 6^{o}$ grid thus it is next plotted on the $10^{o} \times 10^{o}$ grid. The beginning of the scan is denoted by a square. Each 75th point is overstruck with an X. The data block contains the event name, record number, and time at the beginning and end of the record. It also contains other features which need some explanation. The reference coordinates given are the azimuth and elevation of the record point at the center of the scan line rounded off to the nearest degree. The point count contains the total number of points in the record and the number of points plotted. The number of points plotted is always smaller than the total number because: a) the first and last points are always discarded to avoid a commonly observed spurious deviation and b) those points for which the pressure setting of the FP interferometer deviate significantly from the mean pressure for the record are discarded. The

mean pressure is determined by averaging the last ten points of the record left after the very last point is discarded.

On succeeding frames the measured data is plotted against path distance from the initial point measured in subtended degrees along the path. This has the effect of straightening out a linear scan. A specific point can be located roughly by estimating its position between two X marks or accurately by counting the points from the nearest X mark.

In the integral folded version of the record the data from specific channels are presented together so that, for example, the data from the 4934A channel of the FP are along the top half of the first part of the record. This means that in the appendix these data appear on the top half of each of the first 4 pages of the data presentation.

Data are presented for the FP 4934 channel the FP 6142 channel, the photometer channel, and for the point by point ratio of 4934 to photometer intensities.

The left hand axis of each plot is the intensity relative to the maximum intensity in that channel for the specific record. This has the effect of spreading the data more nearly over the entire useable area. The right hand axis is the absolute intensity as derived from calibration. The calibration procedure is described in detail below. The ratio of FP 4934 to the photometer intensity has no readily useable significance by itself but variations in this ratio over the scan are of some interest. For this reason the scale applied has no quantitative significance but is effectively arbitrary.

For each channel the maximum number of counts is printed out. This is the number of counts associated with the highest intensity point. Its main significance is to give an indication of the statistical ($\sqrt{n}$) fluctuation expected.

The data plotted have been reduced by the channel dark count determined during the specific event. For the second FP channel and for the late cloud developments in all channels, the data count ratio is not very much greater than the dark count rate.

Hence the significance of the data under such conditions is highly questionable.

V. APPLICATION OF THE REDUCED DATA

Many uses of the reduced data have been planned and others suggest themselves. The primary use will probably be a comparison of interferometer data with intensities derived densitometrically from photographs of the cloud. To accomplish such a comparison it is necessary to determine the points on the photograph to which the interferometer data apply. This can be done by using the overlays supplied in conjunction with photographs reproduced at the appropriate scale.

In many cases a series of spatial scans covers a nearly constant portion of the cloud and such a series can be useful in performing frame to frame correlations of structure. A preliminary examination of frames 68 to 71 of event Spruce, done before the reduced data were available in the present format, has yielded the qualitative conclusion that certain features do correlate from frame to frame over a period of a few minutes while certain other features may appear in one or two frames but shortly vanish from view. With the data in its present format more detailed study of the evolution of striae and their short term behavior, at least within the plane normal to the line of sight, is possible.

The cloud expansion in its early stages can be studied and non-symmetric models for the expansion process can be matched against the observed intensities over the various scans and scan directions used. Edge steepening can be further studied by using the data plots.

VI. CALIBRATION

The calibration in the field was accomplished using both a low brightness radioactive phosphor (LBS) which had been calibrated against a standard at ESSA some 6 months before use (Reference 3) and an electroluminescent source (ELS) of considerably greater brightness which was calibrated against the LBS on each run.

Calibration was accomplished at the end of each event (with the exception of Plum) and consisted of taking dark counts on all channels, photometer response to LBS, photometer response to ELS, and Fabry-Perot response to ELS.

The LBS was not large enough to fill the entire photometer aperture, so the effective LBS brightness for full aperture was reduced by the ratio of the areas. The LBS had a 2.75 inch active diameter, and the photometer aperture was 4.30 inches in diameter, so the ratio factor is 2.44.

The radiance of the cloud (above the atmosphere) as seen by the photometer can then be written:

$$I_C = \frac{(N_{PC} - N_{PD})}{(N_{PL} - N_{PD})} \times \frac{I_L}{2.44\ T_A}$$

where I_L is the LBS intensity, and T_A is the atmospheric transmission (in which the effect of the plate-glass observation window are included), and the subscripts on N indicate counting rates of the photometer (P) when looking at the clouds (C), the LBS source (L) or dark (D). The LBS intensity incident on the photometer is determined by multiplying the measured continuum radiance of the LBS per angstrom, i_L, by the full-width-at-half-height of the particular interference filter, W_F, in angstroms. The intensity then becomes

$$I_C = \frac{(N_{PC} - N_{PD})}{(N_{PL} - N_{PD})} \times \frac{i_L\ W_F}{2.44\ T_A}$$

Intensities derived thusly should be directly comparable with (filter) photographically derived cloud radiances if both correspond to the same viewing aspect of the cloud.

As Hake et al have pointed out (Reference 3), calculation of the radiance of the cloud from the FP signals is a more complicated matter because the continuum emission from the ELS is further attenuated by the action of the FP. For the purposes of this calibration it is assumed that the portion of the continuum emission passing

the FP is determined by the FP finesse F [F = free spectral range (FSR) divided by the the instrumental full-width-at-half-height] in the relation:

$$i_E = \frac{I_E}{F}$$

where i_E and I_E are ELS intensities. The lower case i_E, as mentioned above, denotes intensity in some frequency interval. In the case above, the frequency interval is one FP passband:

$$W_{FP} = FSR/F$$

or

$$W_{FP}(Hz) = cW_{FP}$$

where FSR = (1/2) t is the free spectral range of the FP, t is the spacer length, and c is the speed of light. (The equation) is dimensionally correct only if it is realized that the ELS intensity I_E is effectively distributed over one FSR of the FP--i.e., I_E = intensity/FSR (Hz).

F was measured pre and post event at the laser wavelength, λ6328 Å, and must be computed for the other wavelengths using FP parameters (plate flatness, primarily) established by the λ6328 Å measurement. If the pre and post event values differ significantly (> 1 unit), then linear interpolation should be used to give F for a particular time. The values determined for F are:

	SPRUCE		REDWOOD		OLIVE	
Wavelength (Å)	$F(W_{FP}/FSR)$		$F(W_{FP}/FSR)$		$F(W_{FP}/FSR)$	
6328	17.0	measured	17.3	measured	19.0	measured
6142	18.4	computed	18.9	computed	20.3	computed
5535	18.4	computed	18.9	computed	20.4	computed
4934	16.6	computed	16.0	computed	17.7	computed

The effective ELS intensity for the FP is determined by calibration against the LBS using the photometer. The relationship is

$$I_E = \frac{i_L \, W_F}{2.05} \times \frac{(N_{PE} - N_{PD})}{(N_{PL} - N_{PD})}$$

The factor 2.05 results from the aperture diameter of the FP being 100 mm instead of the 4.30 inches appropriate to the photometer.

The cloud radiance (above the atmosphere) as determined by FP at a particular point in the spectral line is

$$i_C = i_E \times \frac{(N_{FC} - N_{FD})}{(N_{FE} - N_{FD})} \times \frac{1}{T_A \, T_{FP}}$$

where i_C is again the cloud radiance in a limited spectral width, the passband of the FP. T_{FP} is an FP transmission factor, that arises because the FP was calibrated through the wide field port (no telescope) but the cloud was observed through the telescope. T_{FP} has been taken to be 0.74, from an estimate that includes the obstruction by the secondary mirror and reflection losses from the two additional mirrors in the light path.

The dark counts have been determined to be

EVENT	PHOTOMETER	FP 1	FP 2
Spruce	5.67	4.91	25.2 (15)
Olive	4.28	4.62	21.1 (15)
Redwood	3.09	3.58	17.08 (10)

On FP 2 the dark counts were so large and the signals generally so small that much of the data, after the dark count is subtracted, ends up negative and thus does not appear on the data plots. To avoid this loss of data points the dark count actually subtracted is arbitrarily chosen to be the values in parentheses above.

The radiancy values have been determined absolutely according to the following relationships.

Spruce:

Photometer	$I = 8.25 \times 10^{-6} N^*$
FP 1	$I = 2.47 \times 10^{-15} N^*$
FP 2	$I = 1.1 \times 10^{-13} N^*$

Redwood:

Photometer	$I = 8.45 \times 10^{-6} N^*$
FP 1	$I = 2.84 \times 10^{-15} N^*$
FP 2	$I = 1.89 \times 10^{-13} N^*$

Olive:

Photometer	$I = 8.98 \times 10^{-6} N^*$
FP 1	$I = 2.62 \times 10^{-15} N^*$
FP 2	$I = 7.25 \times 10^{-13} N^*$

The units are for I (photometer), erg/cm^2 sec sr. and for I (FP), erg/cm^2 sec sr. Hz. N^* is the difference between actual counts and dark counts each 0.1 sec

REFERENCES

1. R. D. Hake, Jr., D. Sipler, M. A. Biondi, "Preliminary Optical Interferometer Results from Secede II", (U), Delivered at Preliminary Data Review Meeting at SRI, May 1971.

2. R. Lambert, "Secode II Interferometer: Interim Report", GE Report, to be published 1972.

3. R. D. Hake, Jr., D. P. Sipler, M. A. Biondi, "Absolute Calibration of the Fabry-Perot Interferometer for Secede II", SRI Project Secede Technical Memo 9, 22 September 1971.

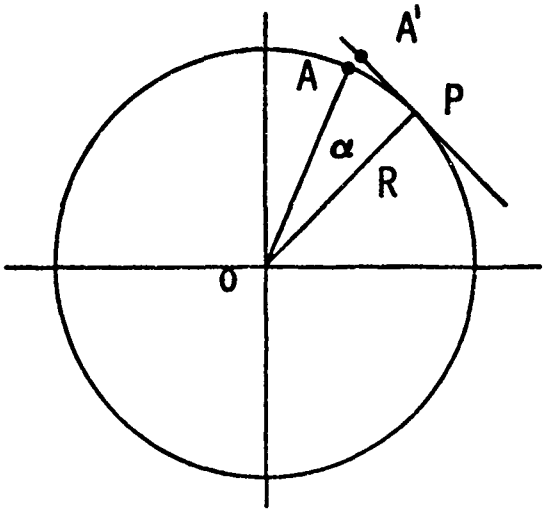


Figure 1

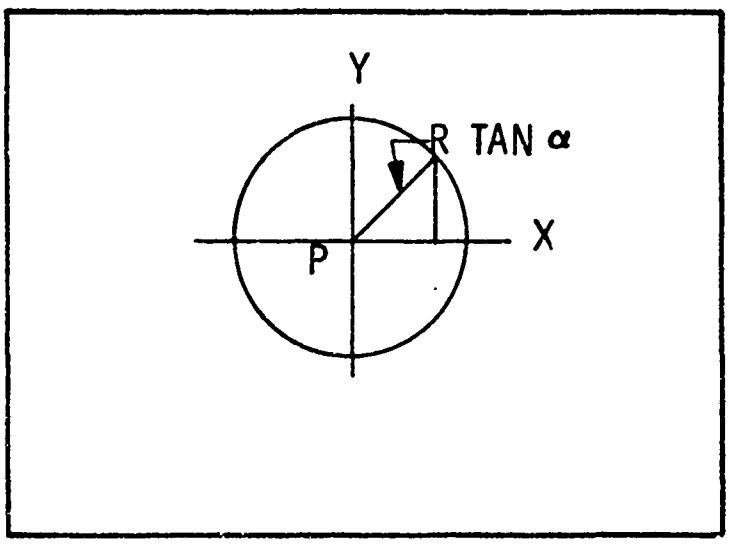
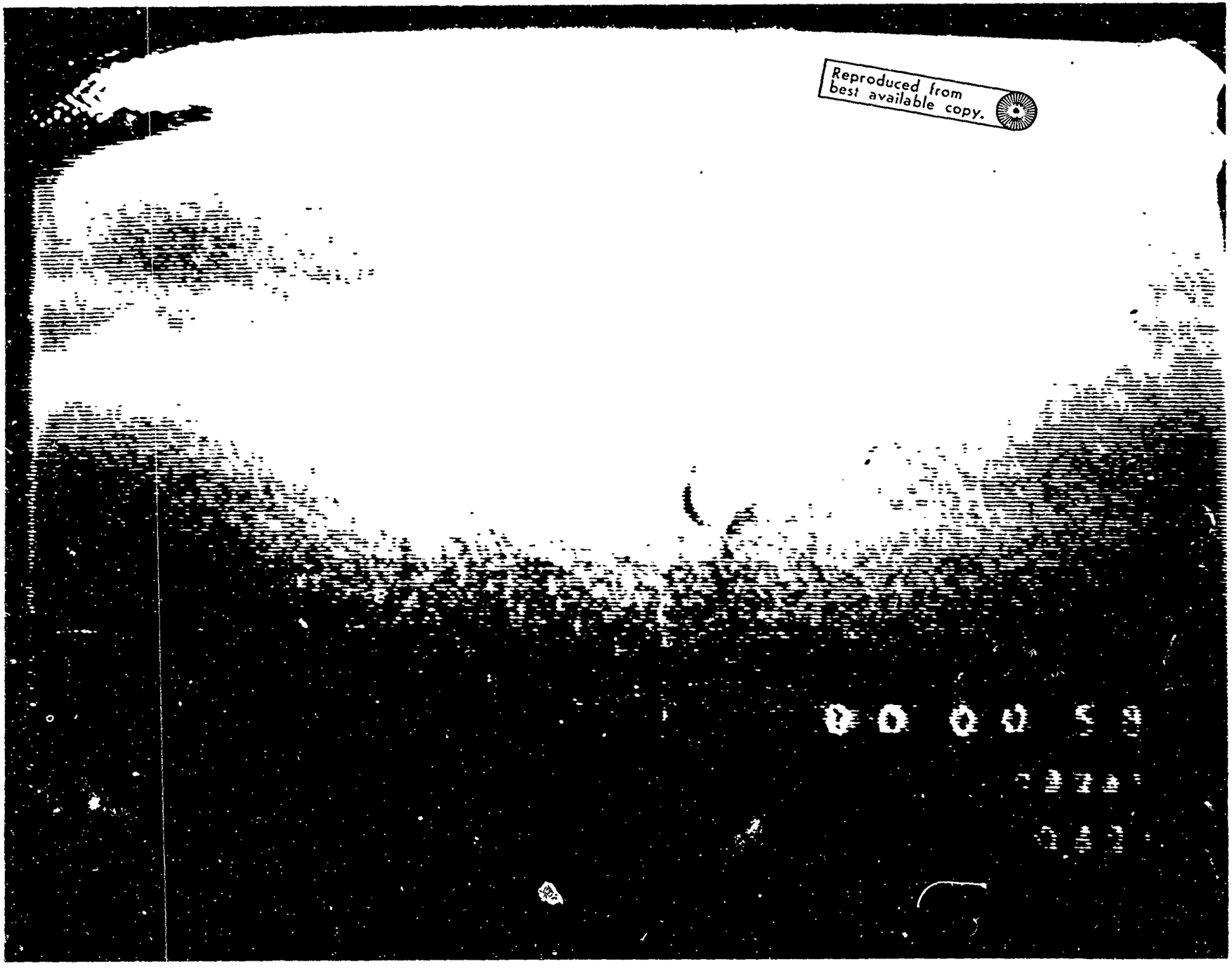
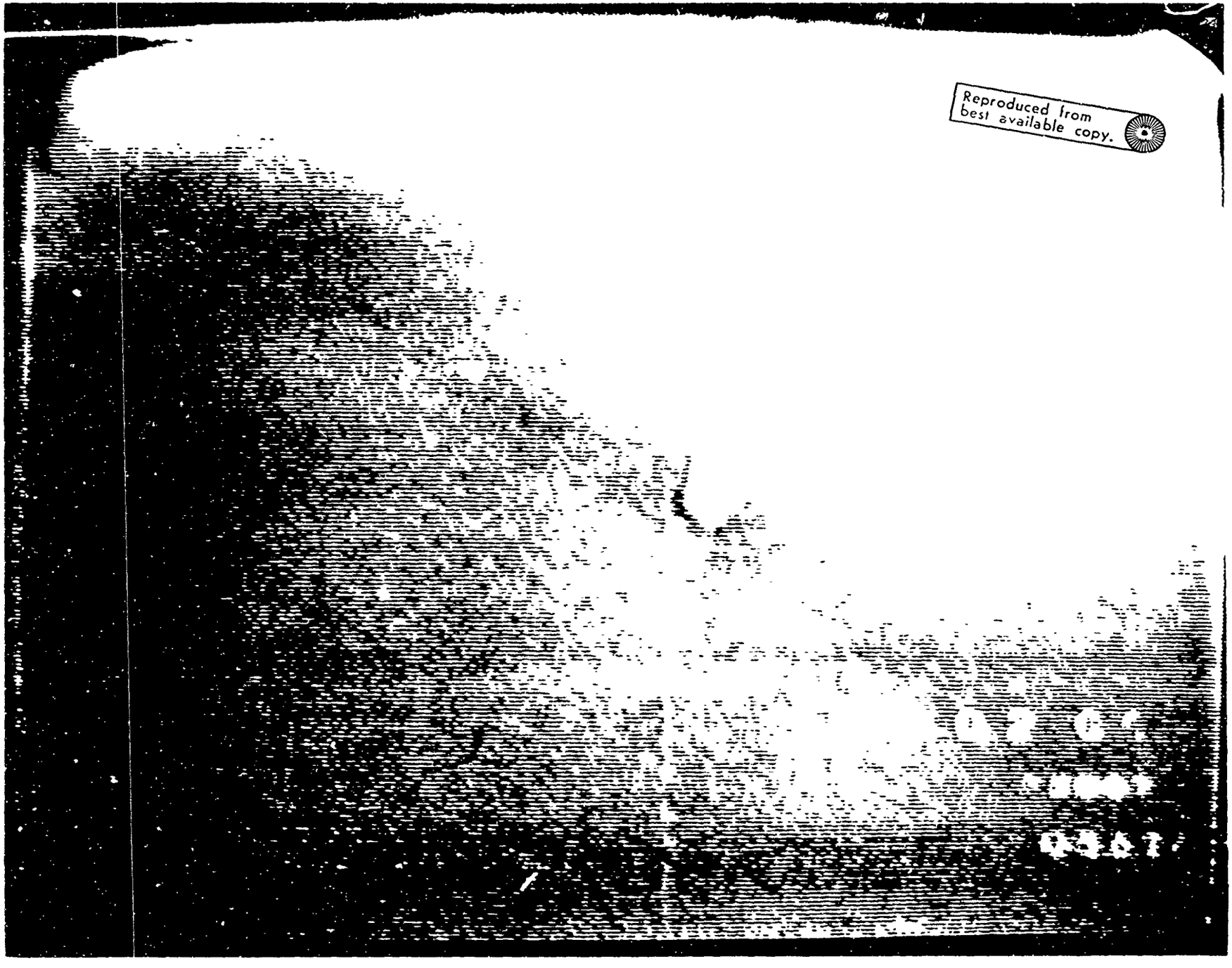


Figure 2

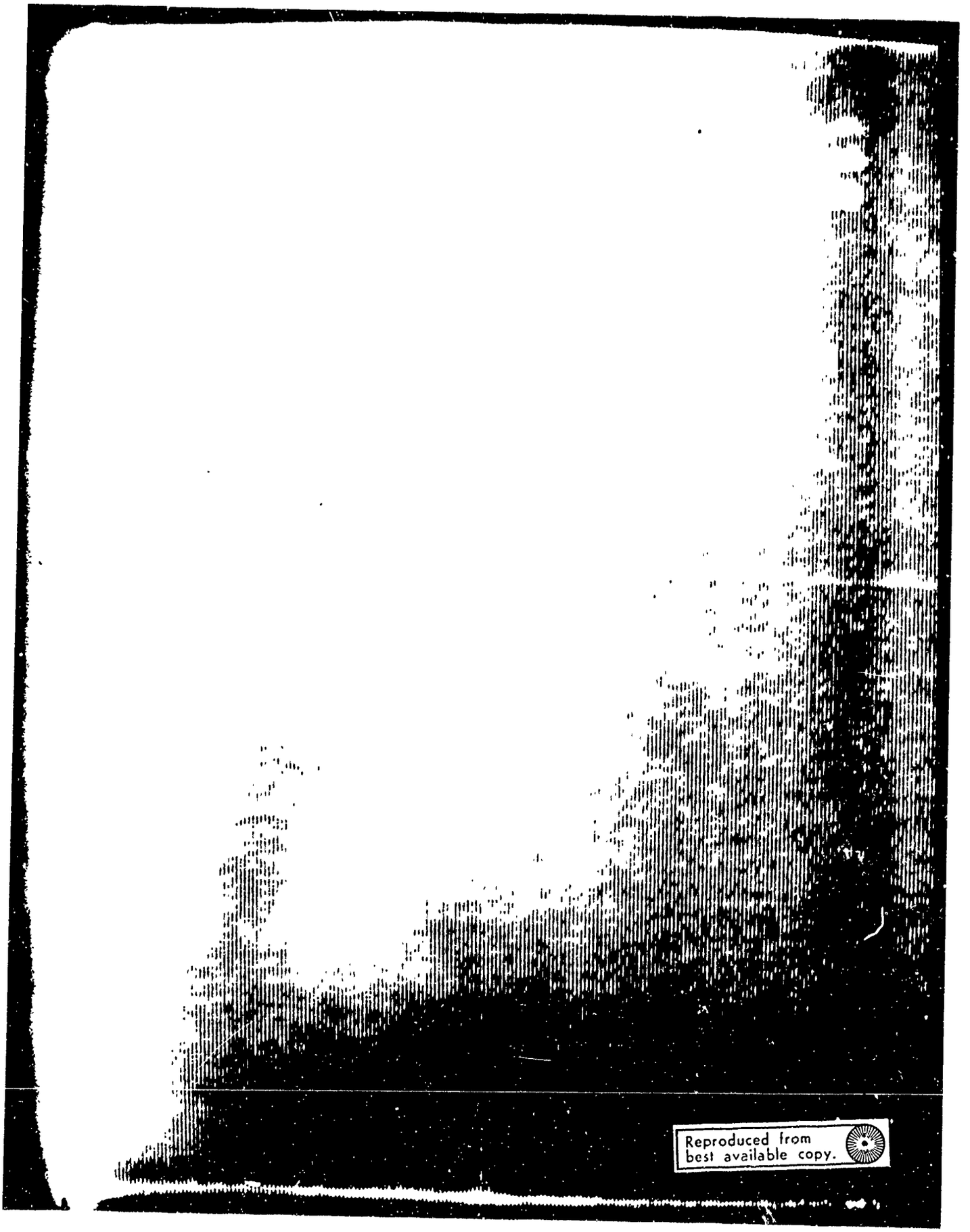
APPENDIX I

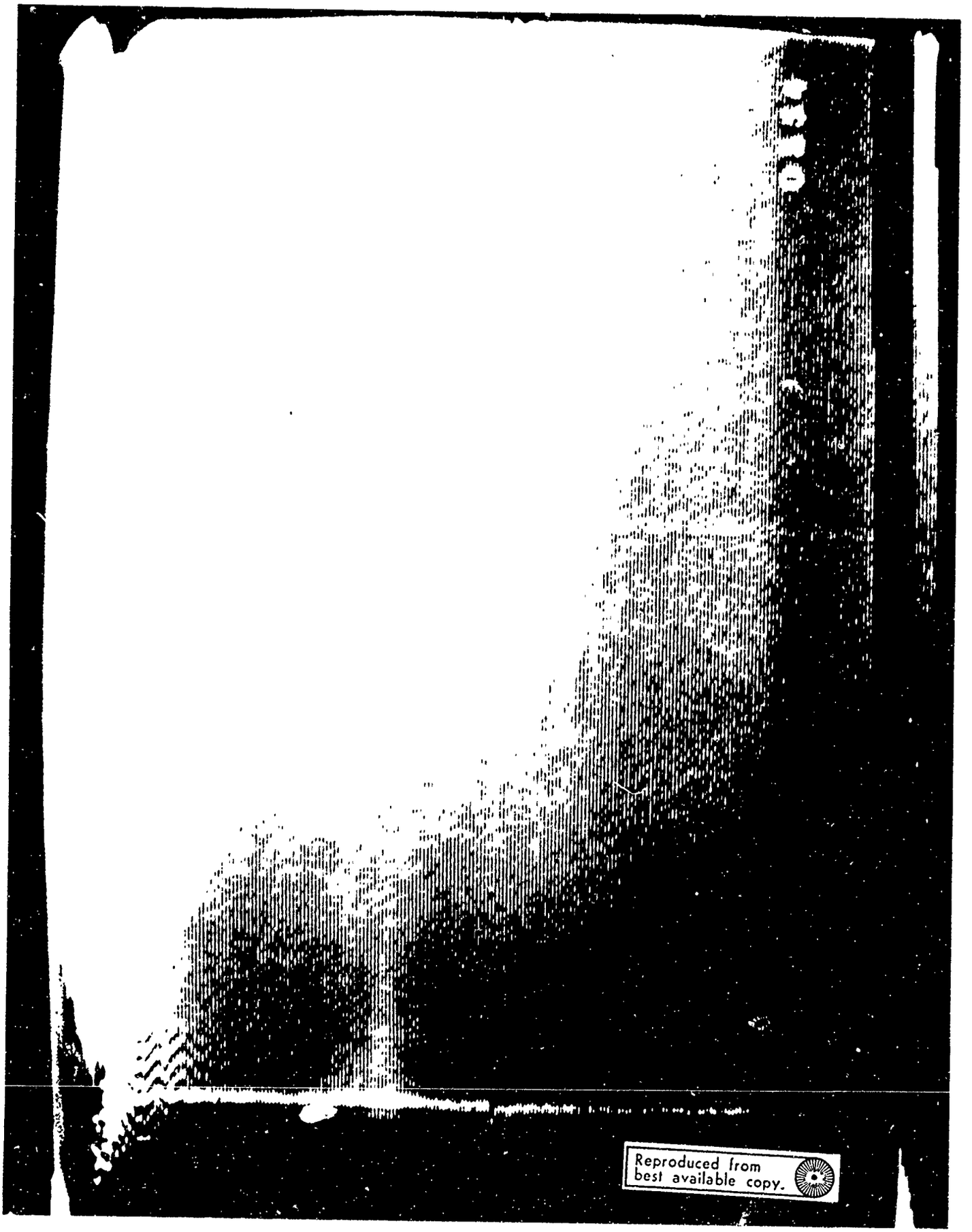
IMAGE ORTHICON PRINTS ON SPRUCE


Reproduced from
best available copy.

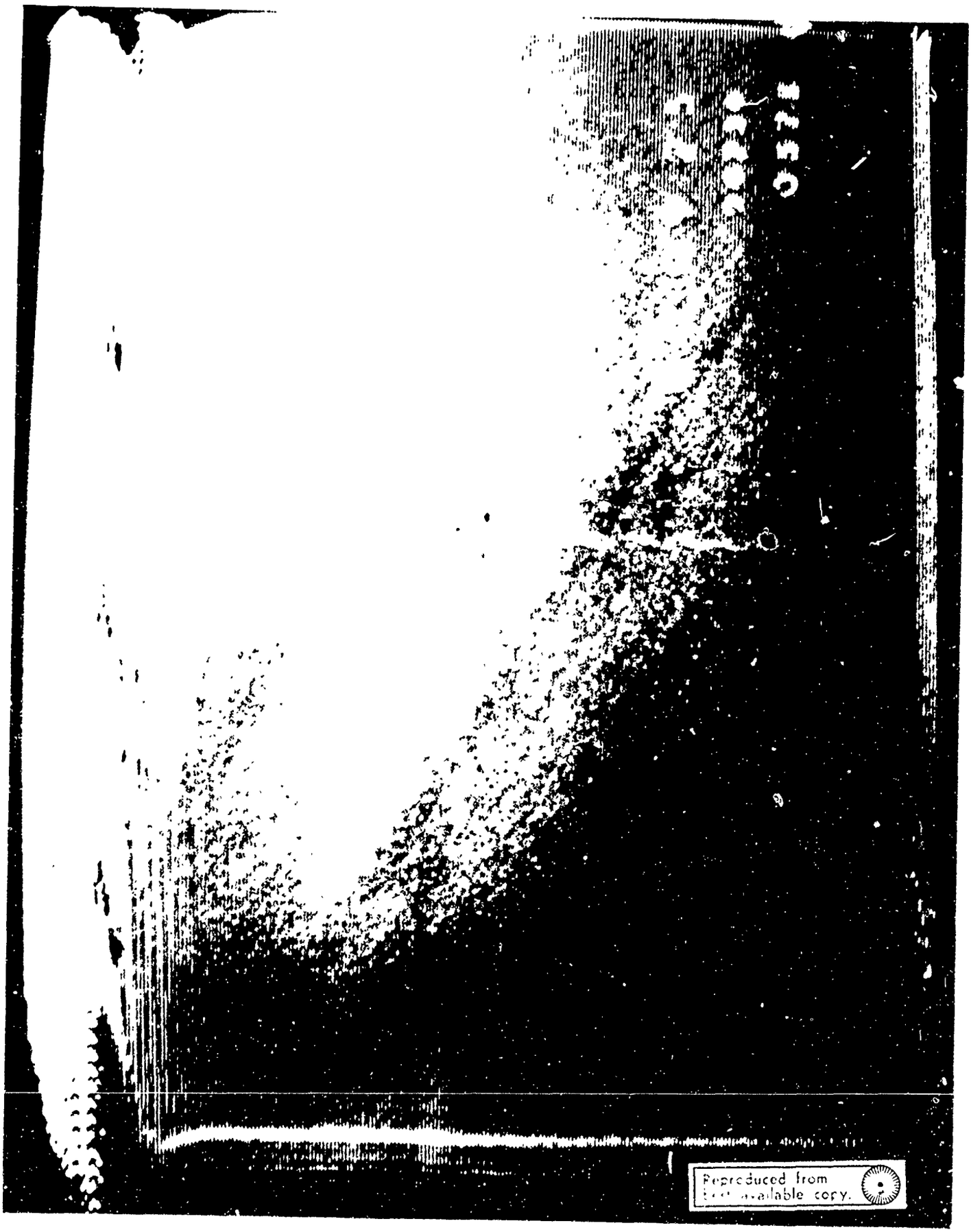


Reproduced from best available copy.

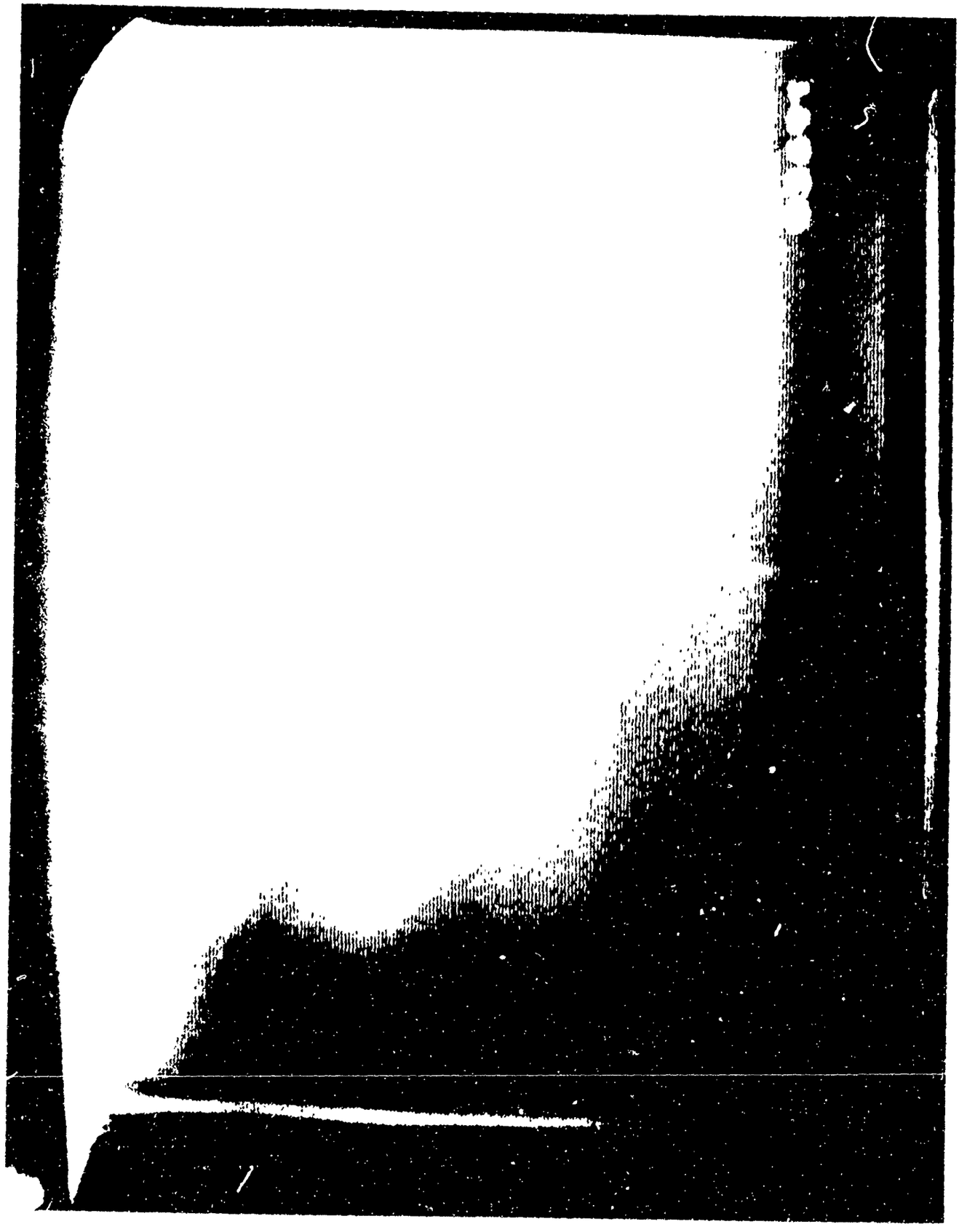

Reproduced from
best available copy.

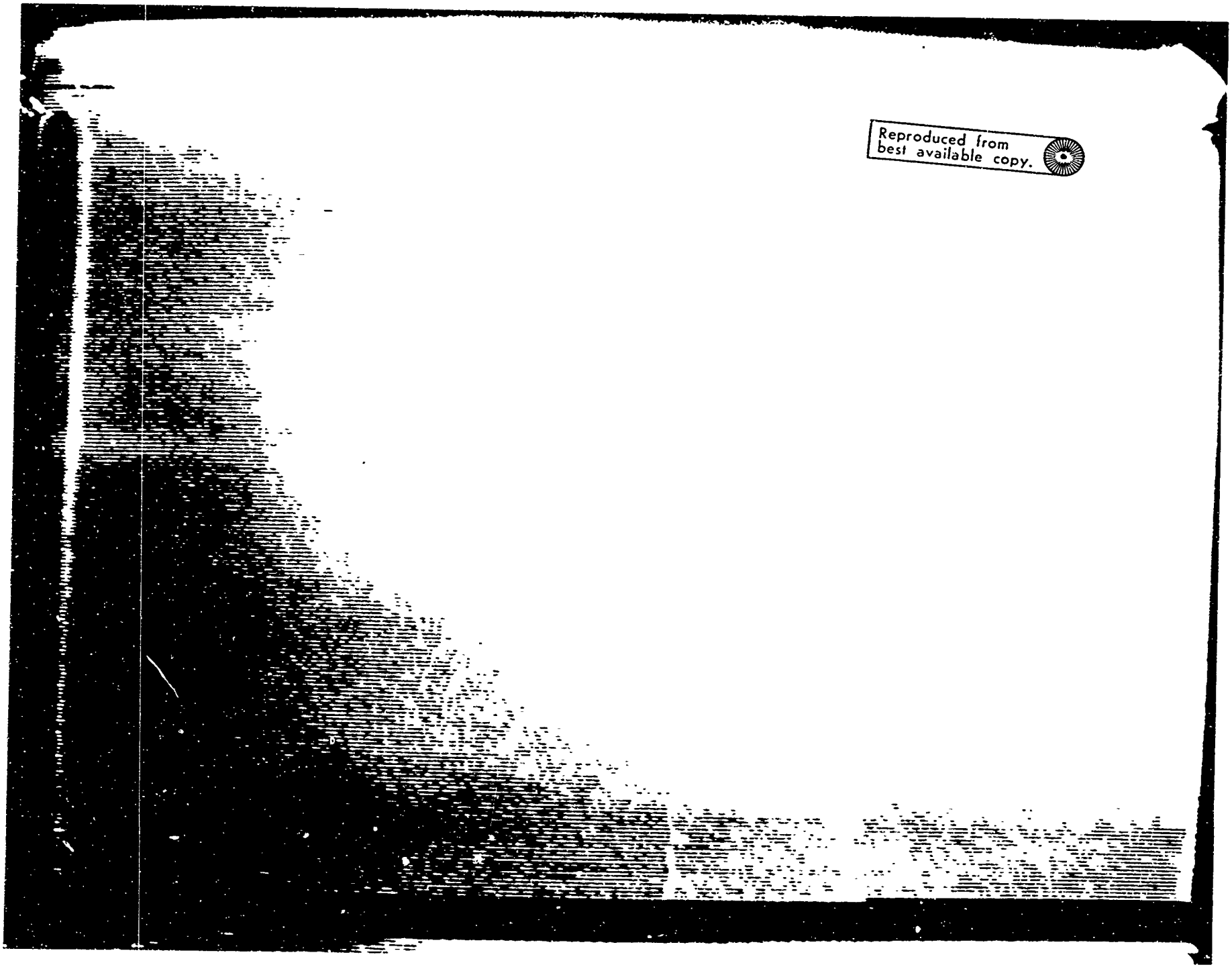


Reproduced from
best available copy.



Reproduced from best available copy.

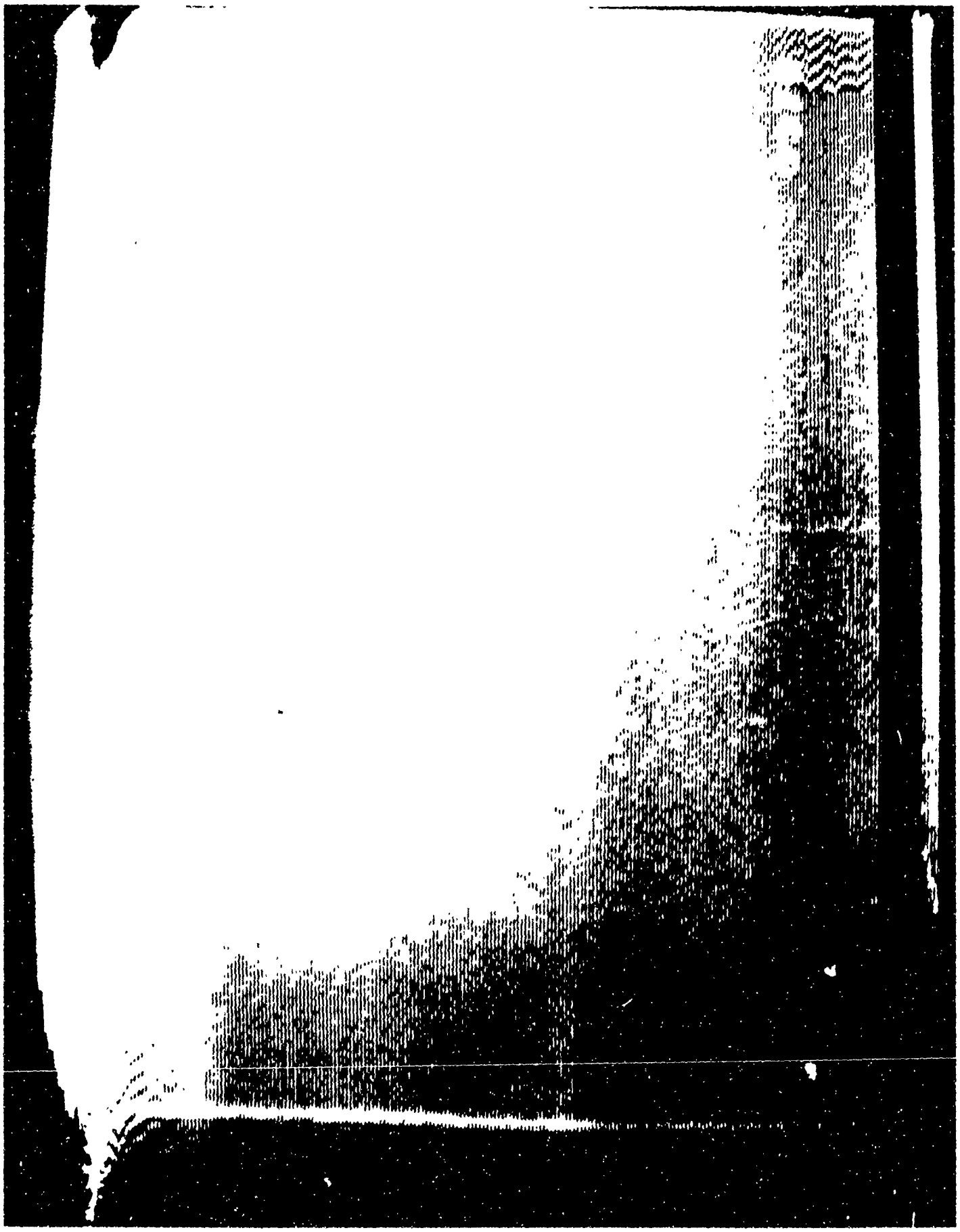




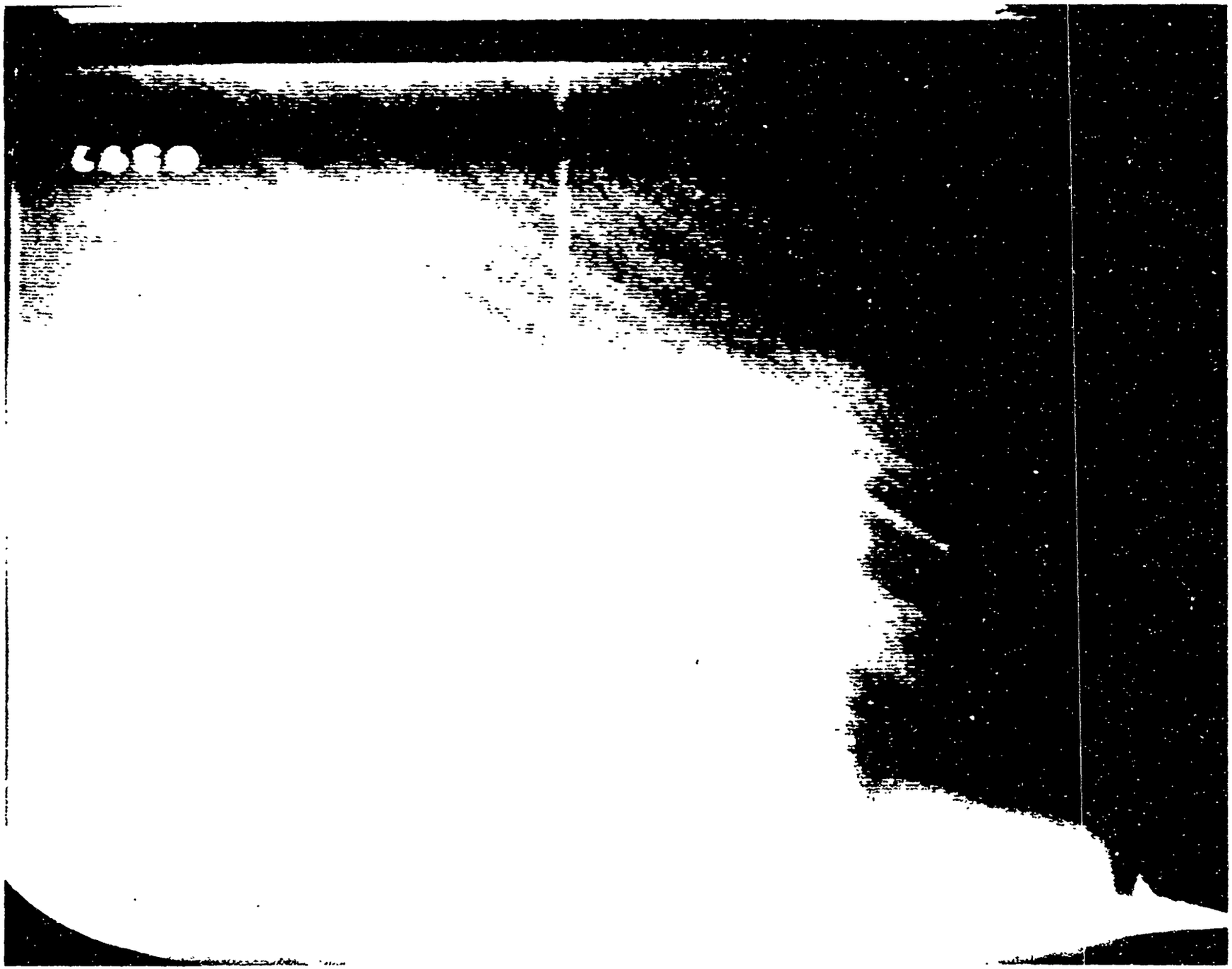
Reproduced from
best available copy.

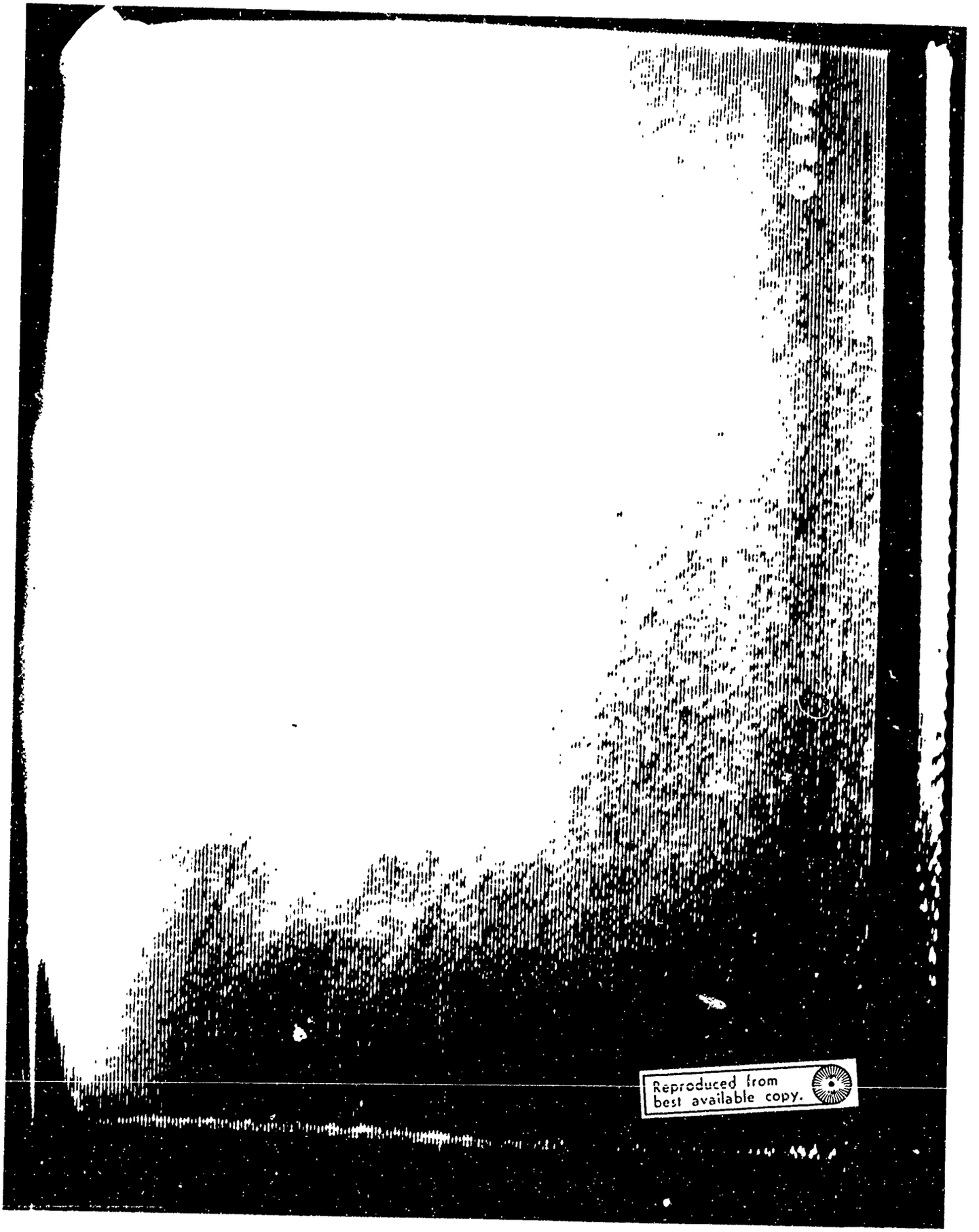
Reproduced from
best available copy.

Reproduced from
best available copy.



Reproduced from
best available copy.



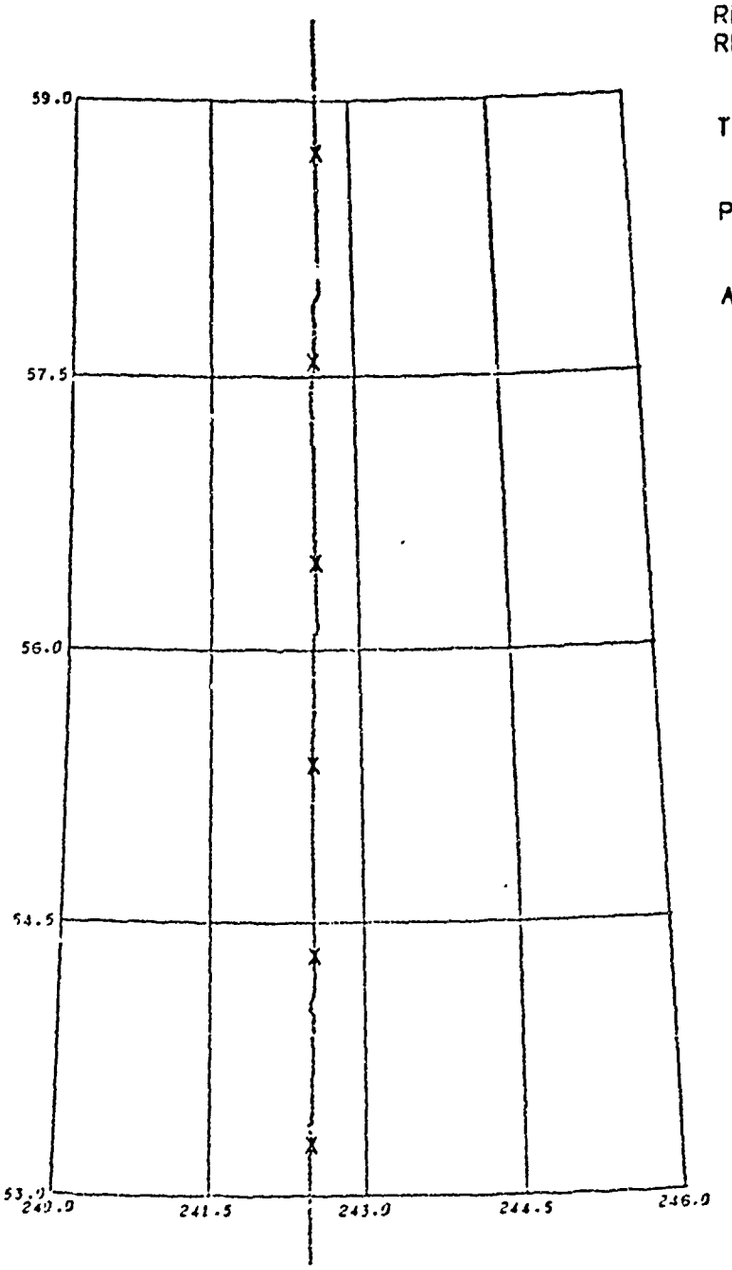

Reproduced from
best available copy.

Reproduced from
best available copy.

Reproduced from
best available copy.

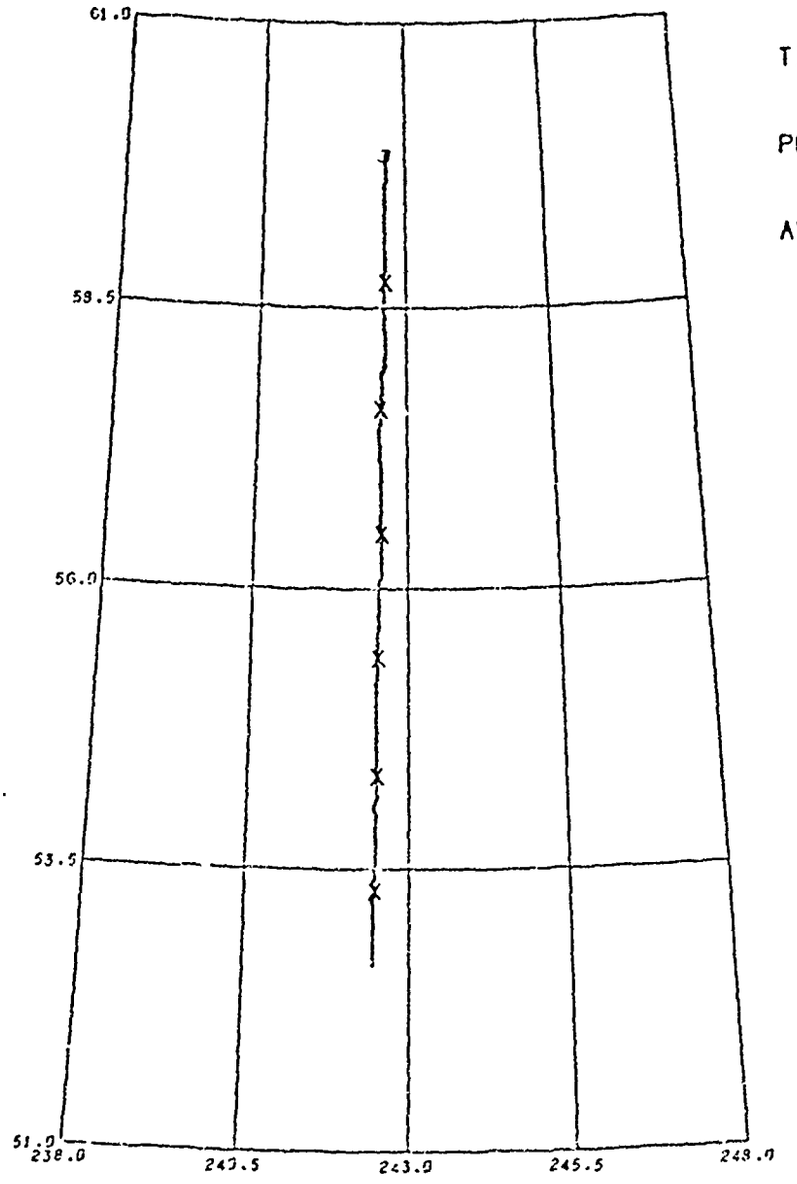
APPENDIX II

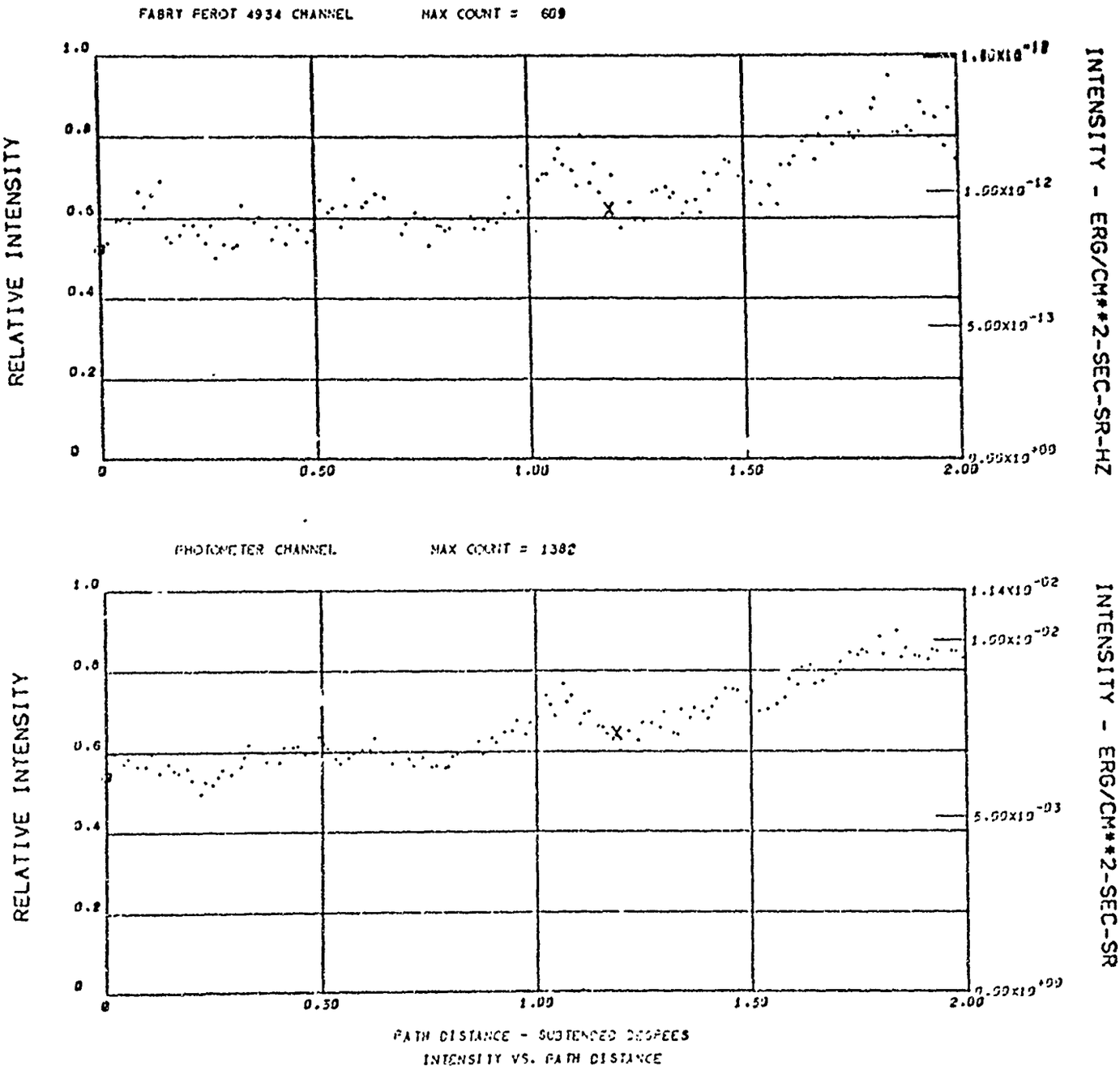
SAMPLE DATA SPRUCE - #101

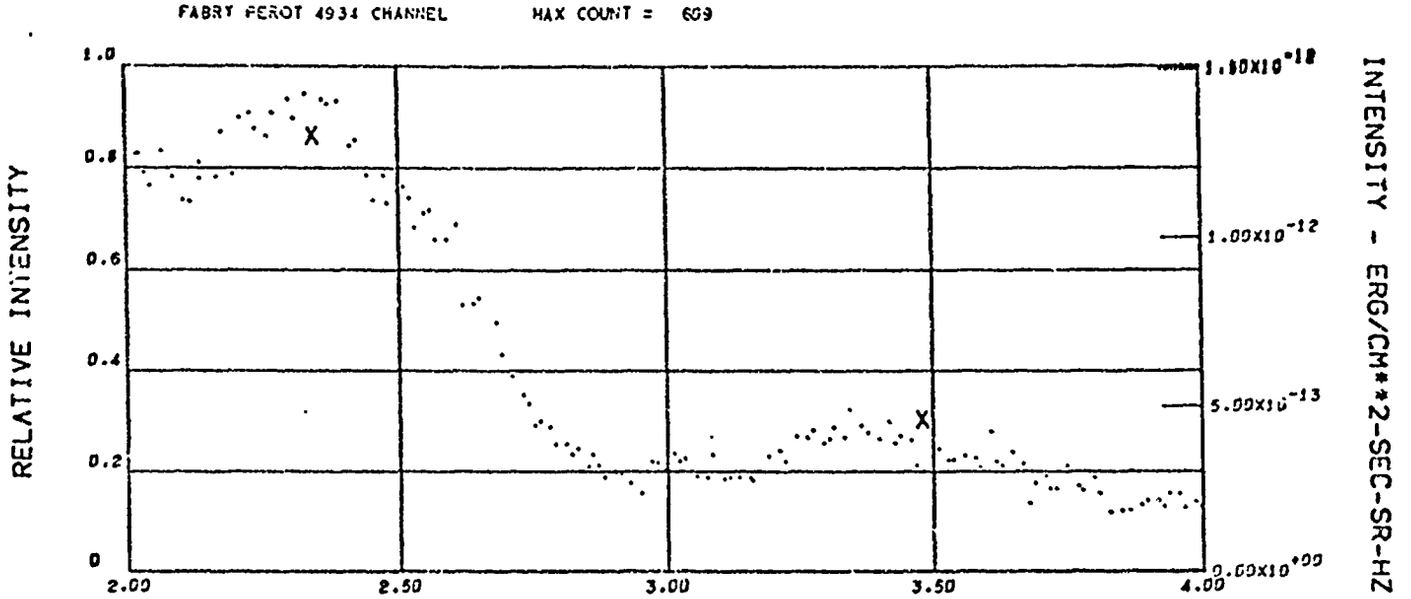


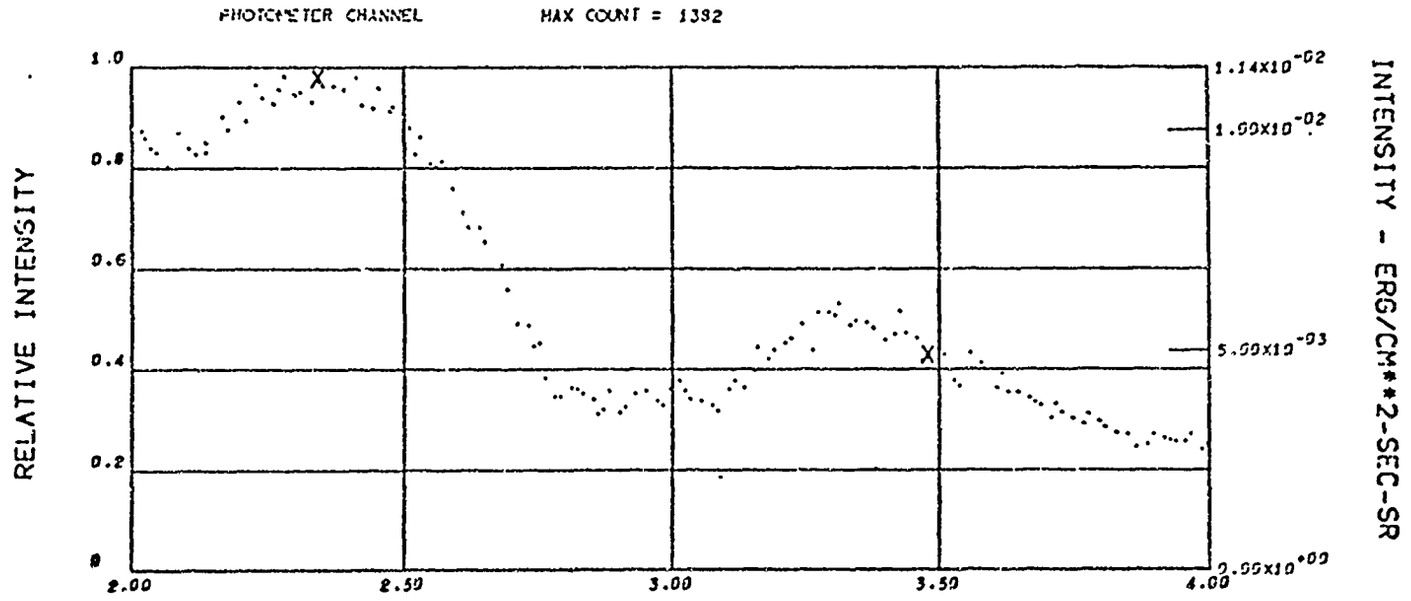
EVENT SPRUCE
RECORD NO. - 101
REF COORD -
AZ 243
EL 56
TIME
START 18M 5.13S
STOP 18M 54.44S
POINT COUNT -
TOTAL 498
PLOTTED 196
AVERAGE PRESSURE -
353

EVENT SPRUCE
RECORD NO. - 101
REF COORD -
AZ 243
EL 56
TIME
START 18M 5.13S
STOP 18M 54.44S
POINT COUNT -
TOTAL 498
PLOTTED 496
AVERAGE PRESSURE -
353

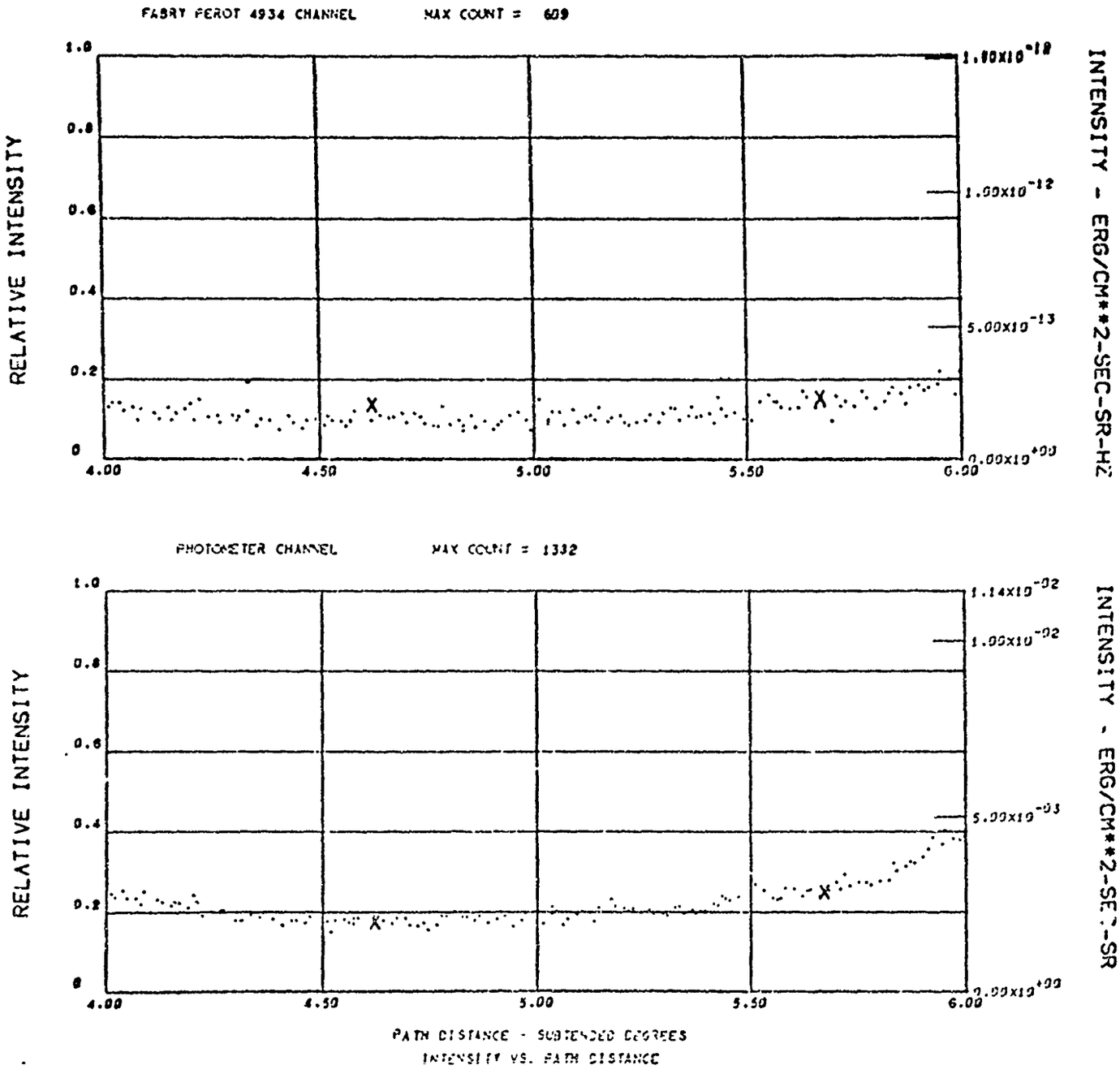


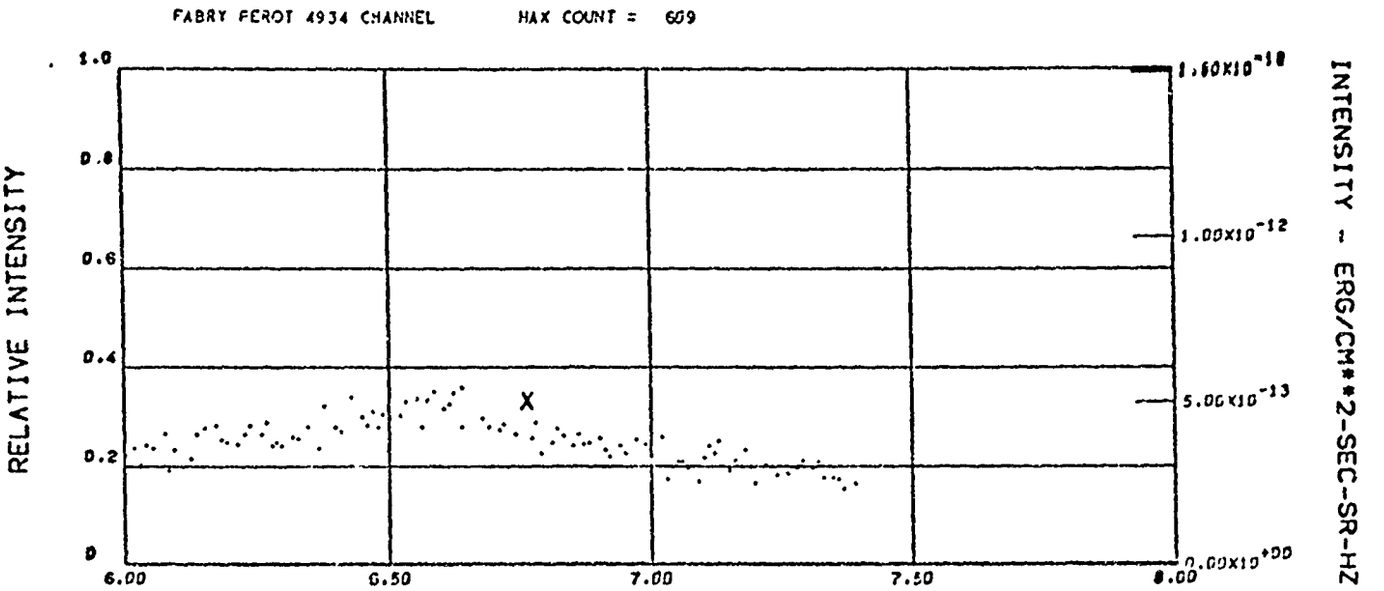

FABRY PEROT 4934 CHANNEL
MAX COUNT = 609
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR-HZ
1.0
0.8
0.6
0.4
0.2
0
0
0.50
1.00
1.50
2.00
1.60X10^-12
1.00X10^-12
5.00X10^-13
0.00X10^+00
PHOTOMETER CHANNEL
MAX COUNT = 1382
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR
1.14X10^-02
1.00X10^-02
5.00X10^-03
0.00X10^+00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE

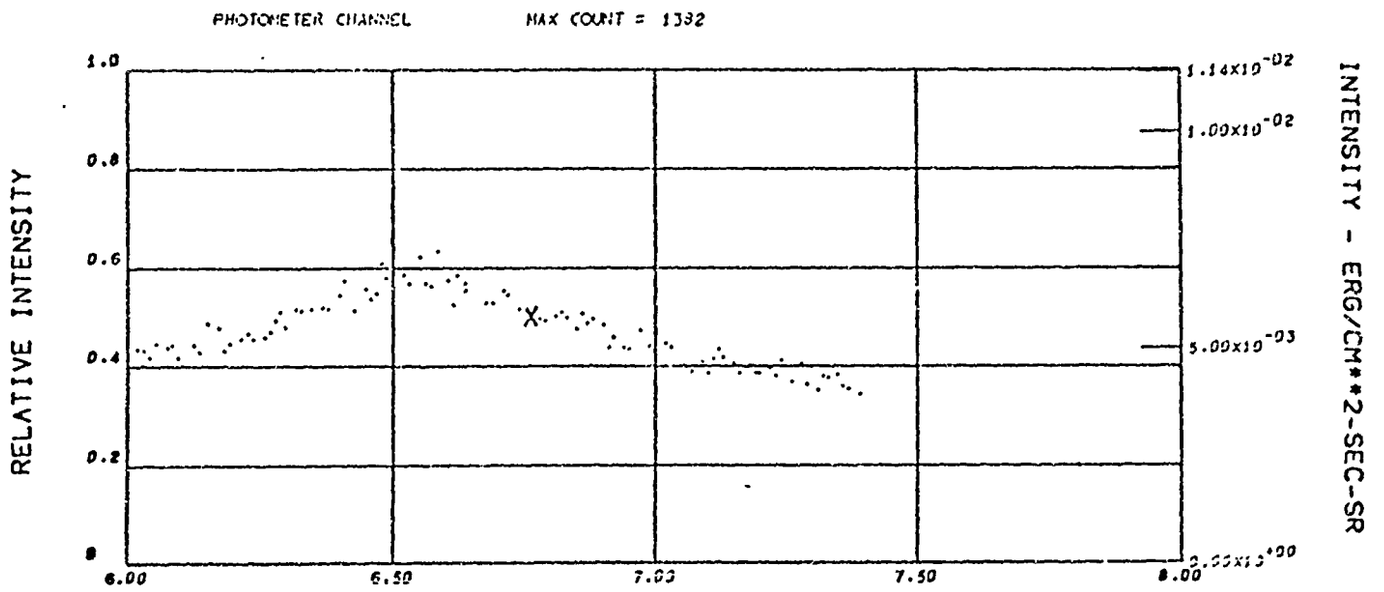




INTENSITY VS. PATH DISTANCE

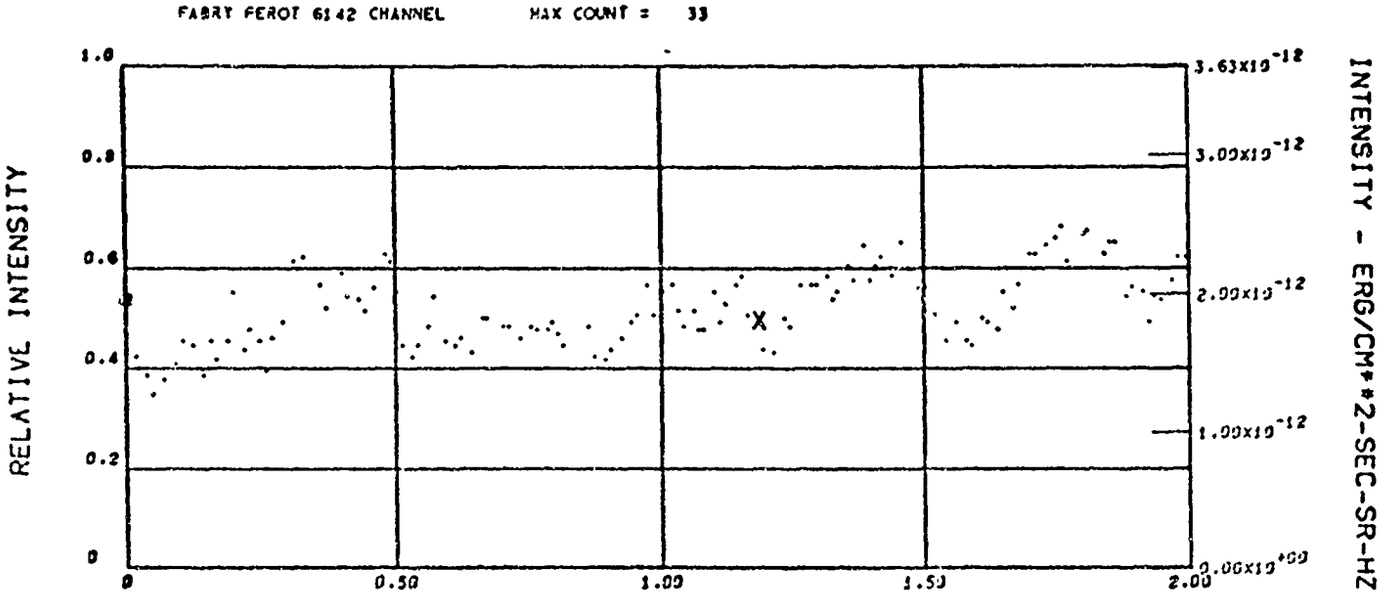

FABRY PEROT 4934 CHANNEL
MAX COUNT = 609
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR-HZ
1.0
0.8
0.6
0.4
0.2
0
1.00X10^-12
5.00X10^-13
0.00X10^+00
4.00
4.50
5.00
5.50
6.00
PHOTOMETER CHANNEL
MAX COUNT = 1332
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR
1.14X10^-02
1.00X10^-02
5.00X10^-03
0.00X10^+00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE

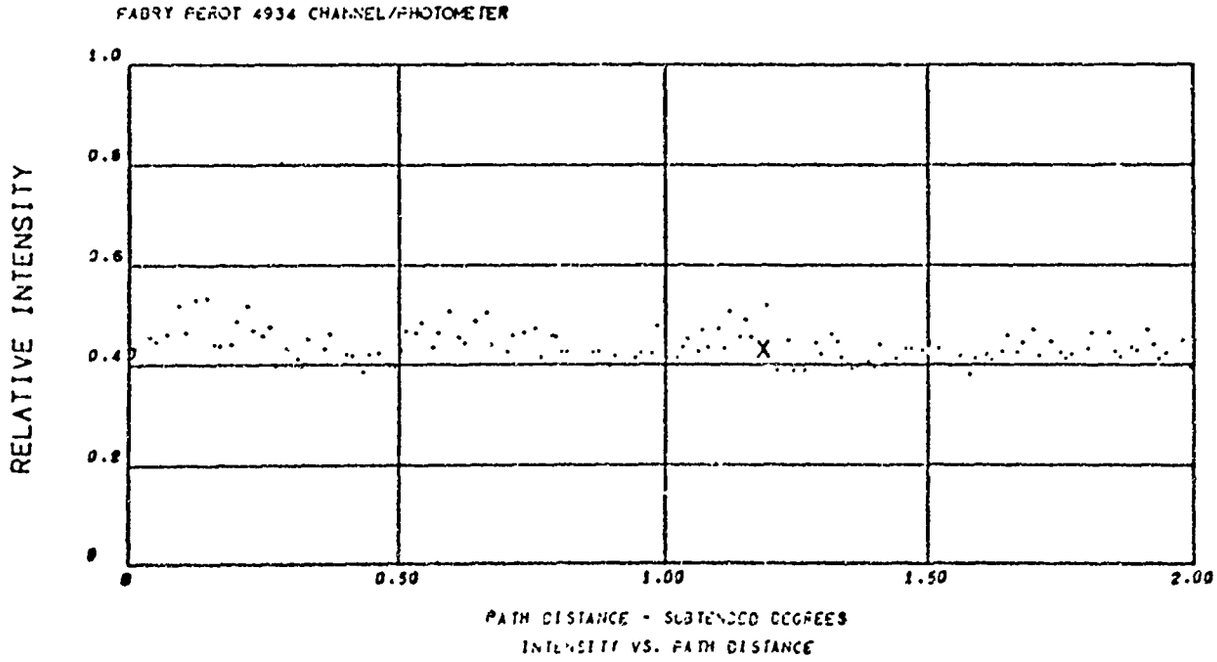


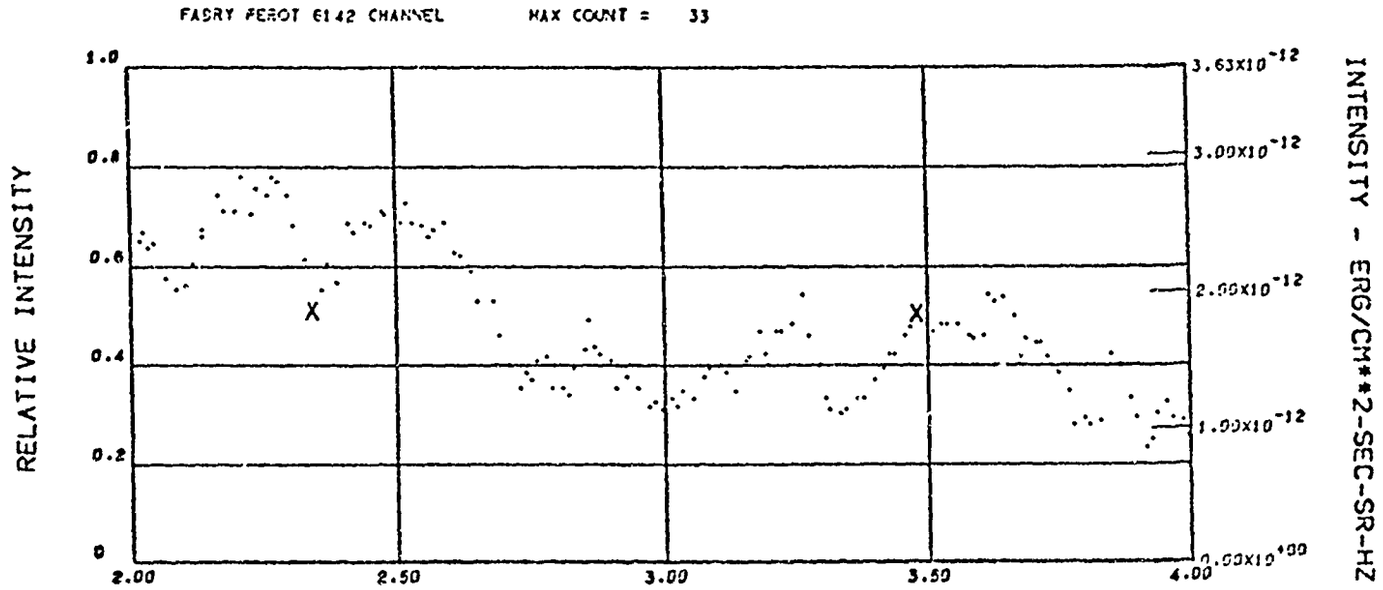


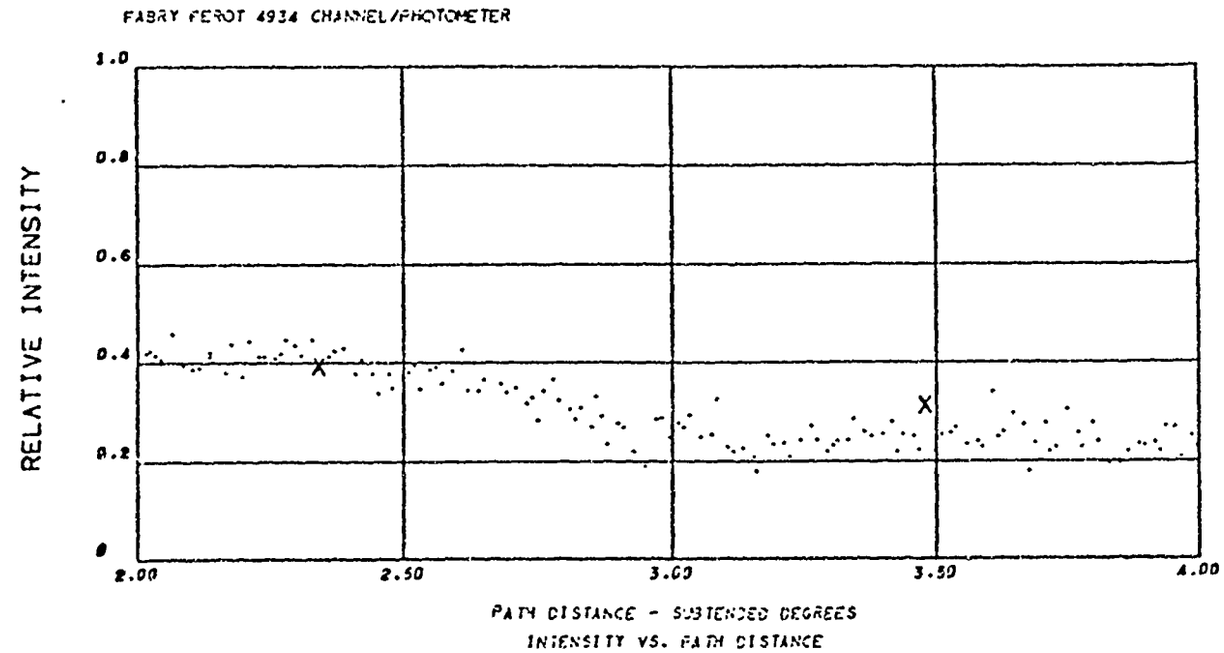
PATH DISTANCE - SUBTENDED DEGREES

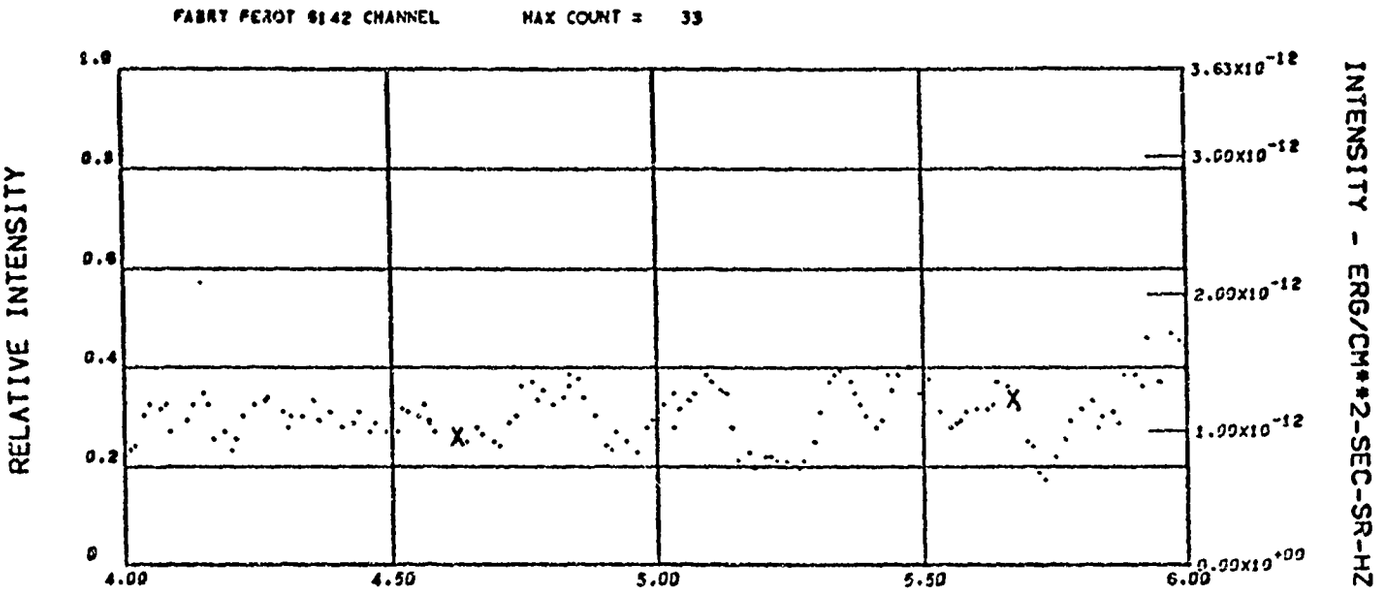
INTENSITY VS. PATH DISTANCE

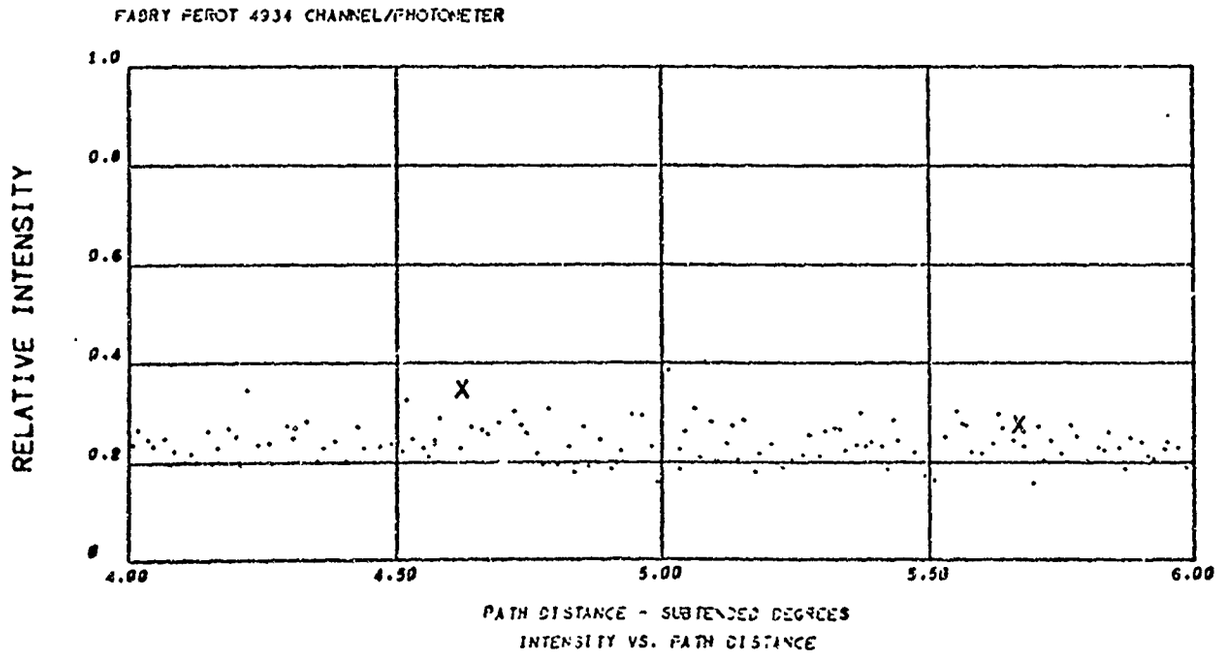

FABRY PEROT 6142 CHANNEL
MAX COUNT = 33
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR-HZ
1.0
0.8
0.6
0.4
0.2
0
0.50
1.00
1.50
2.00
3.63X10-12
3.00X10-12
2.00X10-12
1.00X10-12
0.00X10+00

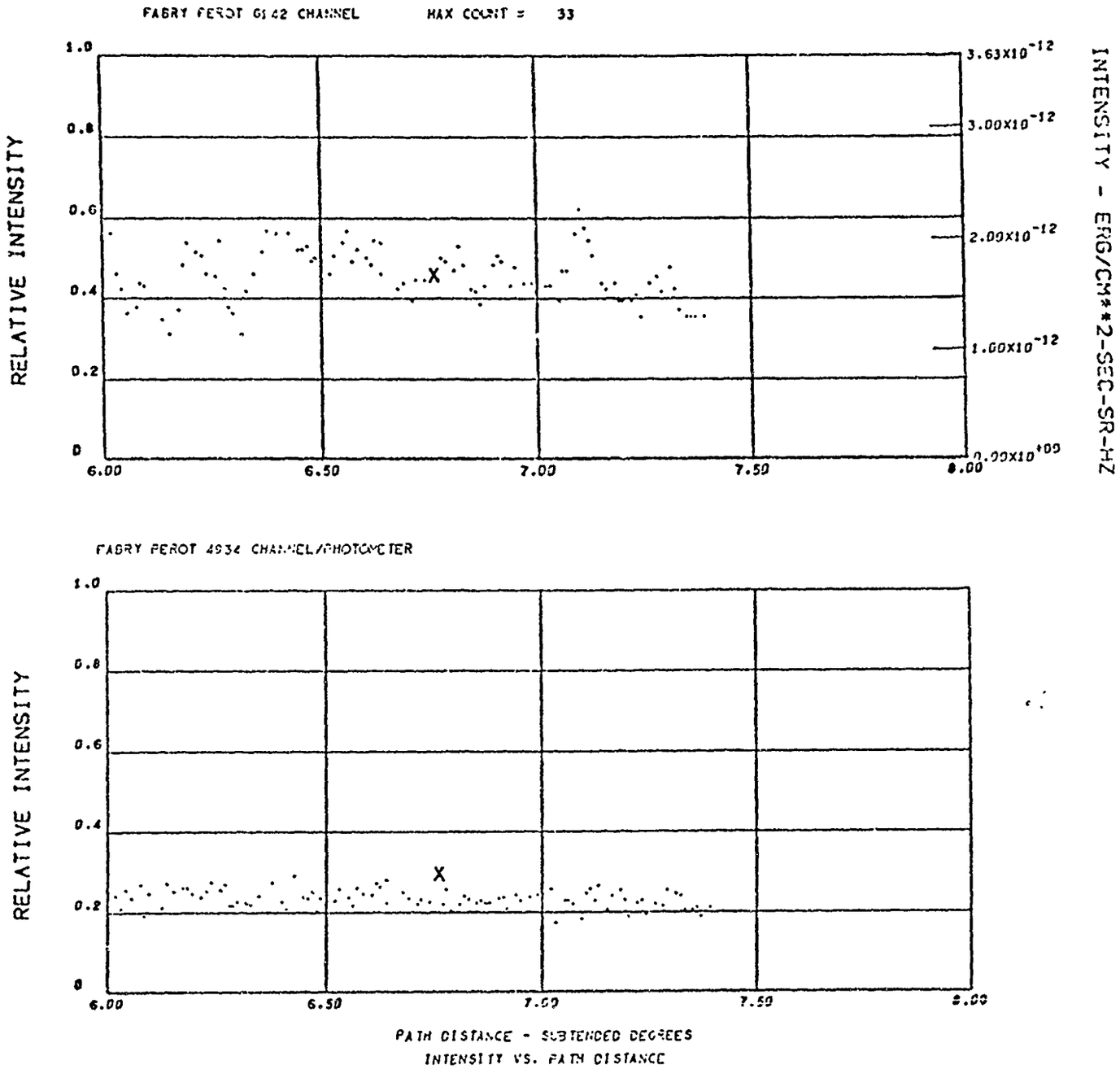

FABRY PEROT 4934 CHANNEL/PHOTOMETER
RELATIVE INTENSITY
1.0
0.8
0.6
0.4
0.2
0
0.50
1.00
1.50
2.00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE


FABRY PEROT 6142 CHANNEL
MAX COUNT = 33
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR-HZ
1.0
0.8
0.6
0.4
0.2
0
3.63X10-12
3.00X10-12
2.00X10-12
1.00X10-12
0.00X10+00
2.00
2.50
3.00
3.50
4.00


FABRY PEROT 4934 CHANNEL/PHOTOMETER
RELATIVE INTENSITY
1.0
0.8
0.6
0.4
0.2
0
2.00
2.50
3.00
3.50
4.00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE


FABRY PEROT 6142 CHANNEL
MAX COUNT = 33
RELATIVE INTENSITY
INTENSITY - ERG/CM**2-SEC-SR-HZ
1.0
0.8
0.6
0.4
0.2
0
3.63X10^-12
3.00X10^-12
2.00X10^-12
1.00X10^-12
0.00X10^+00
4.00
4.50
5.00
5.50
6.00


FABRY PEROT 4934 CHANNEL/PHOTOMETER
RELATIVE INTENSITY
1.0
0.8
0.6
0.4
0.2
0
4.00
4.50
5.00
5.50
6.00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE


FABRY PEROT 6142 CHANNEL
MAX COUNT = 33
RELATIVE INTENSITY
1.0
0.8
0.6
0.4
0.2
0
6.00
6.50
7.00
7.50
8.00
3.63X10-12
3.00X10-12
2.00X10-12
1.00X10-12
0.00X10+00
INTENSITY - ERG/CM**2-SEC-SR-HZ
FABRY PEROT 4934 CHANNEL/PHOTOMETER
RELATIVE INTENSITY
1.0
0.8
0.6
0.4
0.2
0
6.00
6.50
7.00
7.50
8.00
PATH DISTANCE - SUBTENDED DEGREES
INTENSITY VS. PATH DISTANCE

APPENDIX III

PLOTTING PROGRAM

Preceding page blank

WRITTEN BY G.LIEBLING - GENERAL ELECTRIC - AUG 1971

```
CSFCD                    PROGRAM TO PLOT SECEDE DATA TAPES
C          WRITTEN BY G.LIEBLING - GENERAL ELECTRIC - AUG 1971
C


      EXTERNAL TABL1V
      DIMENSION  TITLE(12), LABEL(6,4), NOR(100), IDATA(26),
     2           PRES(700), SEC(700), TMIN(700),
     1           AZ(700), EL(700), FMON(700), FP1(700), FP2(700),
     3           RAZ(700), REL(700), RMON(700), RFP1(700), RFP2(700),
     4           RSEC(700), RMIN(700), RATS(700),
     5           PARRAY(700,4), NAME(3)
      DIMENSION  IXTAB(50), IYTAB(50), DIS(700), XTAB(700), YTAB(700)
      DIMENSION ASCALE(3), FMAX(3), MARTOP(3), MARBOT(3), NTIC(3),
     1          TVAL(10, 3), ILAB(6,3)
      EQUIVALENCE (PARRAY(1,1), RFP1(1)), (PARRAY(1,3), RFP2(1)),
     1           (PARRAY(1,2), RMON(1)), (PARRAY(1,4), RATS(1))
      EQUIVALENCE (IDATA(1), IDAT1), (IDATA(2), IDAT2),
     1    (IDATA(3), IDAT3), (IDATA(4), IDAT4), (IDATA(5), IDAT5),
     2    (IDATA(6), IDAT6), (IDATA(7), IDAT7), (IDATA(8), IDAT8),
     3    (IDATA(9), IDAT9), (IDATA(10), IDAT10), (IDATA(11), IDAT11)
      DATA ((LABEL(I,J), I = 1,6), J = 1,4)
     1     /5H      , 6HFABRY , 6HPEROT , 6H4934 C, 6HHANNEL, 6H      ,
     2      6H      , 6H  PHO, 6HTOMETE, 6HR CHAN, 6HNEL   , 6H      ,
     3      6H      , 6HFABRY , 6HPEROT , 6H6142 C, 6HHANNEL, 6H      ,
     4      6HFABRY , 6HPEROT , 6H4934 C, 6HHANNEL, 6H/PHOTO, 6HMETER /
      DATA ((ILAB(I,J), I = 1,6), J = 1,3)
     1     /6HINTENS, 6HITY -  , 6HERG/CM, 6H**2-SE, 6HC-SR-H, 6HZ     ,
     2      6HINTENS, 6HITY -  , 6HERG/CM, 6H**2-SE, 6HC-SR   , 6H      ,
     3      6HINTENS, 6HITY -  , 6HERG/CM, 6H**2-SE, 6HC-SR-H, 6HZ     /
      DATA RADS/0.0174533/
      DATA IN, IOUT, ITP / 5, 6, 10 /
C     SCALE FACTORS FOR GRIDS
      SCALF1 = 0.020
      DEL1   = 3.0
      DEL2   = 5.0
      DEL3   = 7.0
      MARG   = 60
      LINC   = 30
      LDRAW  = LINC - 1
      FLINC  = LINC
      ONE = 1.00
      CALL CHSIZV (2, 2)
      CALL RITSTV (12, 20, TABL1V)
C
      READ (IN, 5050)  TITLE
      WRITE(IOUT,6010)  TITLE
      READ  (IN, 5050)  NAME
      READ  (IN, 5140)  DARKF1, DARKF2, DARKPH
      READ  (IN, 5160)  ASCALE(1), ASCALE(3), ASCALE(2)
```

```
C       READ FILE NUMBER OF DESIRED FILE
        READ (IN, 5100)  NFILE
C       READ NUMBER OF RECORDS TO BE PROCESSED
C       AND INDEX NUMBER OF EACH RECORD-MAXIMUM 100 RECORDS
        READ (IN, 5120)  NRECS
        READ (IN, 5120)  (NOR(I), I = 1, NRECS)
C
C       SET UP LOOP TO PROCESS EACH RECORD
        READ (ITP)  IDATA
        DO 750  NR = 1, NRECS
        NREC = NOR(NR)
        GO TO 205
C       READ ID FRAME
200     READ (ITP) IDATA
205     IF (IDAT1 - 97 )  200, 210, 200
C       CHECK IF DESIRED FILE
C       CHECK IF DESIRED RECORD
210     IF (IDAT2 - NFILE) 200,220,215
C
C       FILE HAS BEEN BYPASSED- ABORT JOB
215     WRITE (IOUT, 6100)  NFILE, IDAT2
        REWIND ITP
        STOP
C
220     IF (IDAT3 - NREC)  200, 230, 225
C       DESIRED RECORD HAS BEEN PASSED- TRY NEXT RECORD
225     WRITE (IOUT, 6050)  NREC
        GO TO 750
C       DESIRED RECORD FOUND- START READING FRAMES
230     DO 300  NF = 1, 700
240     READ (ITP) IDATA
        IF (IDAT1 - 97)  260, 250, 250
C       ENTIRE RECORD READ - NOW PROCESS DATA
250     NWDS = NF - 1
        IF (NWDS .GE. 15)  GO TO 320
        WRITE (IOUT, 6040)  NREC
        GO TO 750
C       STILL READING RECORD - CONTINUE
260     TEMP1 = IDAT4
        TEMP2 = IDAT5
        AZ(NF) = TEMP1 + (TEMP2 / 100.0 )
        TEMP1 = IDAT6
        TEMP2 = IDAT7
        EL(NF) = TEMP1 + (TEMP2 / 100.0 )
        FMON(NF) = IDAT8
        FP1(NF)  = IDAT9
        FP2(NF)  = IDAT10
        PRES(NF) = IDAT11
        TEMP1 = IDAT3
        TEMP2 = IDAT2
```

```
      SEC(NF) = TEMP2 + (TEMP1 / 100.0)
      TMIN(NF) = IDAT1
  300 CONTINUE
C     IF THIS LOOP COMPLETED MUST HAVE READ 700 POINTS
C     TOO MANY - DISREGARD RECORD
      WRITE (IOUT, 6060)  NREC
      GO TO 750
C     INVERT RECORD AND EXTRACT CONSTANT PRESSURE PART
C     GET AVERAGE OF LAST TEN PRESSURE POINTS
  320 N11 = NWDS - 10
      N1 = NWDS - 1
      N2 = NWDS - 2
      APRES = 0.0
      DO 330  I = N11, N1
  330 APRES = APRES + PRES(I)
      APRES = APRES / 10.0
C     INVERT RECORD - REJECT FIRST AND LAST POINTS
      NREJ = 0
      NREV = 0
      DO 370  IV = 1, N2
      IREV = NWDS - IV
      IF ( ABS(PRES(IREV) - APRES) .LE. 4.0)  GO TO 350
C     IF 5 CONSECUTIVE  POINTS REJECTED DISREGARD REST OF RECORD
      NREJ = NREJ + 1
      IF (NREJ - 5) 370, 400, 400
  350 NREJ = 0
      NREV = NREV + 1
      RSEC (NREV) = SEC (IREV)
      RMIN (NREV) = TMIN(IREV)
      RAZ  (NREV) = AZ (IREV)
      REL  (NREV) = EL (IREV)
      RMON (NREV) = FMON(IREV) - DARKPH
      RFP1 (NREV) = FP1 (IREV) - DARKF1
      RFP2 (NREV) = FP2 (IREV) - DARKF2
  370 CONTINUE
  400 IF (NREV .GT. 5)  GO TO 405
      WRITE (IOUT, 6040)  NREC
      GO TO 750
C
C     NORMALIZE FABRY-PEROT INTENSITIES AND MONITOR
C     FIRST FIND MAX VALUES
  405 F1MAX = RFP1(1)
      F2MAX = RFP2(1)
      FMMAX = RMON(1)
      DO 410 I = 2, NREV
      IF (RMON(I) .GT. FMMAX)  FMMAX = RMON(I)
      IF (RFP1(I) .GT. F1MAX)  F1MAX = RFP1(I)
  410 IF (RFP2(I) .GT. F2MAX)  F2MAX = RFP2(I)
      FMAX(1) = F1MAX
      FMAX(2) = FMMAX
```

```
      FMAX(3) = F2MAX
C
C     ABSOLUTE INTENSITY SCALE
      DO 413  I = 1,3
      ABSMAX = FMAX(I) * ASCALE(I)
      ITEN = INT( ALOG10(ABSMAX) - 1.0)
      UNITS = ABSMAX / 10.0 ** ITEN
      SINC = 2.0
      IF (UNITS .LT. 6.0)  SINC = 1.0
      IF (UNITS .LT. 3.0)  SINC = 0.5
      NTIC(I) = UNITS / SINC + 2.0
      SINC = SINC * 10.0 ** ITEN
      NTICR = NTIC(I)
      NTIC1 = NTICR - 1
      TVAL(1, I) = 0.0
      TVAL(NTICR, I) = ABSMAX
      DO 413  J = 2, NTIC1
413   TVAL(J,I) = TVAL(J-1, I) + SINC
C
C     REINVERT ARRAYS
      NREV2 = NREV / 2
      DO 415  I = 1, NREV2
      NEW = NREV + 1 - I
      TEMP = RAZ(I)
      RAZ(I) = RAZ(NEW)
      RAZ(NEW) = TEMP
      TEMP = REL(I)
      REL(I) = REL(NEW)
      REL(NEW) = TEMP
      DO 415  J = 1, 3
      TEMP = PARRAY(I, J)
      PARRAY(I, J) = PARRAY(NEW, J)
415   PARRAY(NEW, J) = TEMP
C
C     NOW NORMALIZE. ALSO GET RATIO OF MONITOR TO FP1
      DO 420  I = 1, NREV
      RATS(I) = RFP1(I) / RMON(I)
      RMON(I) = RMON(I) / FMMAX
      RFP1(I) = RFP1(I) / F1MAX
420   RFP2(I) = RFP2(I) / F2MAX
C
C     TAKE APPROPRIATE AVERAGE OF FP2 CHANNEL
      NAVG = 5
      IF (F2MAX .GE.  25.0)  NAVG = 4
      IF (F2MAX .GE.  50.0)  NAVG = 3
      IF (F2MAX .GE. 100.0)  NAVG = 2
      IF (F2MAX .GE. 200.0)  NAVG = 1
      IF (NAVG .EQ. 1)  GO TO 424
      FAVG = NAVG
      NREVA = NREV - NAVG + 1
```

```
      DO 422  I = 1, NREVA
      SUM = 0.0
      DO 421  J = 1, NAVG
      IJ = I + J - 1
421   SUM = SUM + RFP2(IJ)
422   RFP2(I) = SUM / FAVG
      NREVA = NREVA + 1
      DO 423  I = NREVA, NREV
423   RFP2(I) = RFP2(I-1)
424   CONTINUE
C
C     READY TO SET UP AZ EL PLOT ON 'GNOMONIC' PROJECTION
C     DETERMINE CENTER COORD
      IPASS = 1
      NHALF = NREV / 2
      AZCENT = AINT(RAZ(NHALF))
      ELCENT = AINT(REL(NHALF))
      IF ((RAZ(NHALF) - AZCENT) .GT. 0.5)  AZCENT = AZCENT + 1.0
      IF ((REL(NHALF) - ELCENT) .GT. 0.5)  ELCENT = ELCENT + 1.0
      AZCENR = AZCENT * RADS
      ELCENR = ELCENT * RADS
C
C     DETERMINE MIN AND MAX ANGLES AND DELTAS
      AZMAX = 0.0
      AZMIN = 0.0
      ELMAX = 0.0
      ELMIN = 0.0
      DO 470  I = 1, NREV
      TEMP = RAZ(I) - AZCENT
      IF (TEMP - AZMAX )  430, 450, 425
425   AZMAX = TEMP
      GO TO 450
430   IF (TEMP - AZMIN)  440, 450, 450
440   AZMIN = TEMP
450   TEMP = REL(I) - ELCENT
      IF (TEMP - ELMAX)  460, 470, 455
455   ELMAX = TEMP
      GO TO 470
460   IF (TEMP - ELMIN)  465, 470, 470
465   ELMIN = TEMP
470   CONTINUE
      DELAZ = AZMAX - AZMIN
      DELEL = ELMAX - ELMIN
      DELANG = DELAZ
      IF (DELEL .GT. DELAZ)  DELANG = DELEL
C
C     FIRST PLOT ON 6X6 DEG SCALE
      SCALE = SCALE1
      DEL = DEL1
C     INSERT BLANK FRAME
```

```
      CALL FRAMEV (3)
475   ELBOT = ELCENT - DEL
      ELTOP = ELCENT + DEL
      AZLFT = AZCENT - DEL
      AZRGT = AZCENT + DEL
C     ADVANCE FILM
      CALL FRAMEV (2)
      DSCALE = DEL * SCALE
      ESCALE = - DSCALE
C     SCALE GRID PAPER- LEAVE 50 UNIT MARGINS
      CALL XSCALV ( ESCALE, DSCALE, MARG, MARG)
      CALL YSCALV ( ESCALE, DSCALE, MARG, MARG)
C
C     DRAW LONGITUDE LINES
      DINC = DEL / 2.0
      AZLINE = AZLFT
      DO 480  I= 1,  5
      CALL COORD (XL1, YL1, AZCENR, ELCENR, AZLINE, ELBOT)
      CALL COORD ( XL2, YL2, AZCENR, ELCENR, AZLINE, ELTOP)
      IXL1 = IXV (XL1)
      IXL2 = IXV (XL2)
      IYL1 = IYV (YL1)
      IYL2 = IYV (YL2)
      CALL LINEV ( IXL1, IYL1, IXL2, IYL2)
C     DETERMINE LIMITS FOR USE IN INTENSITY PLOTS
      IF (I .NE. 3)  GO TO 477
      DELY = YL2 - YL1
      DSCL = (2.0 * DEL) / DELY
C     LABEL LINE
477   IXL1 = IXL1 - 24
      IYL1 = IYL1 - 10
      CALL LABLV (AZLINE, IXL1, IYL1, 6, 1, 4 )
480   AZLINE = AZLINE + DINC
C
C     DRAW LATITUDE LINES
C     SINCE LATITUDE LINES ARE ARCS MUST TRACE OUT IN STRAIGHT SEGMENTS
      AINC = DEL * 2.0 / FLINC
      ELLINE = ELBOT
      DO 500  I = 1, 5
      AZLINE = AZLFT
      DO 490  J = 1, LDRAW
      CALL COORD ( XL1,  YL1,  AZCENR, ELCENR, AZLINE, ELLINE)
      IXTAB(J) = IXV (XL1)
      IYTAB(J) = IYV (YL1)
490   AZLINE = AZLINE + AINC
C     TABLE OF COORDINATES FOR LATITUDE LINE COMPUTED - NOW DRAW LINE
      DO 500 J = 2, LDRAW
500   CALL LINEV ( IXTAB(J-1), IYTAB(J-1), IXTAB(J), IYTAB(J))
C     LABEL LAT LINE
      IXL1 = IXTAB(1) - 46
```

```
      CALL LABLV (ELLINE, IXL1, IYTAB(1), 6, 1, 4 )
  520 ELLINE = ELLINE + DINC
C     WRITE INFO BLOCK
      CALL DBLOCK ( NAME, NREC, AZCENT, ELCENT, RMIN(NREV), RSEC(NREV),
     1              RMIN(1), RSEC(1), NWDS, NREV, ARRES)
C
C     GRID DRAWN AND LABELED
C     CONVERT POINTS TO X - Y COORDINATES FOR PLOTTING
C
      DO 560  I = 1, NREV
  560 CALL  COORD (XTAB(I), YTAB(I), AZCENR, ELCENR, RAZ(I), REL(I) )
C     NOW PLOT
      CALL APLOTV ( NREV, XTAB, YTAB, 1, 1, 1, 42, IERR)
C     PLOT EVERY 75TH POINT WITH SPECIAL SYMBOL
      CALL APLOTV ( 1, XTAB, YTAB, 1, 1, 1, 63, IERR)
      IF (NREV .LT. 75)  GO TO 567
      DO 565  I = 75,NREV,75
      IX = NXV ( XTAB(I))
      IY = NYV ( YTAB(I))
  565 CALL RITE2V ( IX, IY, 1000, 90, 1, 1, -1, 1HX, IERR)
C
C     PLOT FINISHED - REPLOT IF NECESSARY ON COMPRESSED SCALE
  567 GO TO ( 570, 590, 590 ), IPASS
  570 IF (DELANG .LE. (2.0 * DEL1) )  GO TO 590
      IF (DELANG .GT. (2.0 * DEL2) )  GO TO 580
      DEL = DEL2
      IPASS = 2
      GO TO 475
  580 DEL = DEL3
      IPASS = 3
      GO TO 475
  590 CONTINUE
C
C     PLOTTING OF GNOMONIC PROJECTIONS COMPLETED
C
C
C     NOW PLOT INTENSITIES
C
C     GENERATE TABLE OF LINEAR DISTANCES FROM FIRST POINT
      DIS(1) = 0.0
      DO 620  I = 2,NREV
      DINC = SQRT( (XTAB(I) - XTAB(I-1)) ** 2 +
     1             (YTAB(I) - YTAB(I-1)) ** 2 ) * DSCL
  620 DIS(I) = DIS(I-1) + DINC
C     NUMBER OF FRAMES / ARRAY - 2 DEG / FRAME
      FRM = DIS(NREV) / 2.0
      IF ((FRM - AINT(FRM)) .GT. 0.0)  FRM = FRM + 1.0
      NFRAME = FRM
C
C     MARGINS
```

WRITTEN BY G.LIEBLING - GENERAL ELECTRIC - AUG 1971

```
C       TOP HALF
        MARTOP(1) = 1023 - 924
        MARBOT(1) = 544
C       BOTTOM HALF
        MARTOP(2) = 1023 - 462
        MARBOT(2) = 82
        MARLFT    = 66
        MARRGT    = 1023 - 89
        DO 690  IFM = 1,3,2
C       2 DEGREES / FRAME
        DO 680  IFRAM = 1, NFRAME
        CALL FRAMEV (2)
        FRM = IFRAM
        DLEFT = (FRM - 1.0) * 2.0
        DRGHT = FRM * 2.0
        CALL PRINTV (33, 33HPATH DISTANCE - SUBTENDED DEGREES, 364, 60)
        CALL PRINTV (27, 27HINTENSITY VS. PATH DISTANCE, 388, 40)
C       2 ARRAYS / FRAME
        DO 680  IPL = 1,2
C       DRAW GRID
        CALL SETMIV ( MARLFT, MARRGT, MARBOT(IPL), MARTOP(IPL))
        CALL GRID1V ( 2, DLEFT, DRGHT, 0.0,  ONE, 0.50, 0.20, 0, 0,
     1                    1, 1, 4, 3 )
        LINE = MARBOT(IPL) + 86
        CALL RITE2V (30, LINE, 1000, 180, 1, 18, 1,
     1              18HRELATIVE INTENSITY, IERR )
        LINE = 1044 - MARTOP(IPL)
        IGR = IFM + IPL - 1
        CALL PRINTV ( 36, LABEL(1, IGR), 100, LINE )
        IF (IGR .EQ. 4)  GO TO 630
        CALL PRINTV ( 12, 12HMAX COUNT = , 400, LINE )
        CALL LABLV  ( FMAX(IGR), 500, LINE, 4, 1, 4 )
        LINE = 1008 - MARTOP(IPL)
        CALL RITE2V ( 1000, LINE,  50, 0, 1, 31, 1, ILAB(1,IGR), IERR)
C       DRAW ABSOLUTE INTENSITY TIC MARKS
        LSTOP = IXV(DRGHT)
        LSTART = LSTOP - 30
        LCHAR = LSTOP + 10
        NTICR = NTIC(IGR)
        DO 625  NT = 1, NTICR
        POS = TVAL(NT, IGR) / TVAL(NTICR, IGR)
        IPOS = NYV(POS)
        CALL LINEV ( LSTART, IPOS, LSTOP, IPOS )
625     CALL LABLV ( TVAL(NT, IGR), LCHAR, IPOS, -3, 1, 1 )
630     CONTINUE
C
C       PLOT POINTS
        CALL APLOTV (NREV, DIS, PARRAY(1,IGR), 1, 1, 1, 42, IERR)
        CALL APLOTV ( 1, DIS, PARRAY(1,IGR), 1, 1, 1, 63, IERR)
        IF (NREV .LT. 75)  GO TO 680
```

```
      DO 670  I = 75,NREV,75
      IX = NXV ( DIS(I))
      IY = NYV ( PARRAY(I,IGR))
      IF (IX .EQ. 0  .OR.  IY .EQ. 0)  GO TO 670
      CALL RITE2V ( IX, IY, 1000, 90, 1, 1, -1, 1HX, IERR)
670   CONTINUE
680   CONTINUE
690   CONTINUE
700   CONTINUE
C     END LOOP FOR ONE SCAN FRAME
      WRITE (IOUT, 6070) NREC
750   CONTINUE
      REWIND ITP
      STOP
C
5050  FORMAT (12A6)
5100  FORMAT (I2)
5120  FORMAT (10I5)
5140  FORMAT (3F10.3)
5160  FORMAT (3E10.3)
6010  FORMAT (1H1, 30X, 12A6 / )
6040  FORMAT ( / 35X  7HRECORD , I3, 30H SKIPPED - INSUFFICIENT POINTS )
6050  FORMAT ( / 35X  7HRECORD , I3, 28H SKIPPED - NOT FOUND ON TAPE )
6060  FORMAT ( / 35X  7HRECORD , I3, 26H SKIPPED - TOO MANY POINTS )
6070  FORMAT ( / 35X  7HRECORD , I3,  8H PLOTTED )
6100  FORMAT ( ///  6H FILE , I2, 17H BYPASSED - FILE , I2, 6H FOUND;
     1         / 12H JOB ABORTED )
      END
```

566 WORDS OF MEMORY USED BY THIS COMPILATION

01-05-72 13.749 SUBROUTINE TO COMPUTE GNOMONIC PROJECTION COORDINATES FROM INPUT AZ AND EL

```
CCORD       SUBROUTINE TO COMPUTE GNOMONIC PROJECTION COORDINATES
C           FROM INPUT AZ AND EL
      SUBROUTINE COORD ( X, Y, AZCENR, ELCENR, AZ, EL)
      DATA RADS/0.01745331/
      AZR = AZ * RADS
      ELR = EL * RADS
      SINL = SIN(AZR - AZCENR)
      COSL = COS(AZR - AZCENR)
      SINP = SIN(ELR)
      COSP = COS(ELR)
      SINPO = SIN(ELCENR)
      COSPO = COS(ELCENR)
      DENOM = SINPO * SINP + COSPO* COSP * COSL
      X = ( SINL * COSP)/ DENOM
      Y = ( COSPO * SINP - SINPO * COSL * COSP) / DENOM
      RETURN
      END
```

546 WORDS OF MEMORY USED BY THIS COMPILATION

01-05-72 13.751 SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK

ON GNOMONIC PROJECTION PLOTS

```
CDBLK       SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK
C           ON GNOMONIC PROJECTION PLOTS
C           USES VECTOR CHARACTERS FOR LARGER LETTERS
      SUBROUTINE DBLOCK (NAME, NREC, AZCENT, ELCENT, RMSRT, RSSRT,
     1                   RMSTP, RSSTP, NWDS, NREV, APRES)
      EXTERNAL TABL1V
      DIMENSION NAME(3)
      ILF = 790
      IH  = 980
      IDEL=  20
      MAR = 1023
      CALL CHSIZV (2, 2)
      CALL RITSTV ( 12, 20, TABL1V)
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 18, 1, NAME, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 13, -1, 13HRECORD NO. - , IERR)
      TEMP = NREC
      CALL BNBCDV ( TEMP, BCD, NDS)
      CALL RITE2V ( 946, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 11, -1, 11HREF COORD - , IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1,  5, -1, 5H  AZ , IERR)
      CALL BNBCDV ( AZCENT, BCD, NDS)
      CALL RITE2V ( 850, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1,  5, -1, 5H  EL , IERR)
      CALL BNBCDV ( ELCENT, BCD, NDS)
      CALL RITE2V ( 850, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1,  4, -1, 4HTIME, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 18, -1, 18H  START    M    .  S,
     1                                                    IERR)
      CALL BNBCDV ( RMSRT, BCD, NDS)
      IST = 886
      IF (NDS .EQ. 1)  IST = 898
      CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      TEMP = AINT (RSSRT)
      CALL BNBCDV ( TEMP, BCD, NDS)
      IST = 934
      IF (NDS .EQ. 1)  IST = 946
      CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      TEMP = RSSRT - TEMP
      CALL BNBCDV ( TEMP, BCD, NDS)
      CALL RITE2V ( 970, IH, MAR, 90, 1,   2, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 18, -1, 18H  STOP     M    .  S,
     1                                                    IERR)
      CALL BNBCDV ( RMSTP, BCD, NDS)
```

```
L  01-05-72   13.75t   SUBROUTINE TO PRINT HOUSEKEEPING DATA BLOCK
                                ON GNOMONIC PROJECTION PLOTS
      IST = 886
      IF (NDS .EQ. 1)  IST = 898
      CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      TEMP = AINT (RSSTP)
      CALL BNBCDV ( TEMP, BCD, NDS)
      IST = 934
      IF (NDS .EQ. 1)  IST = 946
      CALL RITE2V ( IST, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      TEMP = RSSTP - TEMP
      CALL BNBCDV ( TEMP, BCD, NDS)
      CALL RITE2V ( 970, IH, MAR, 90, 1,   2, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 13, -1, 13HPOINT COUNT -, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1,  7, -1, 7H  TOTAL, IERR)
      TEMP = NWDS
      CALL BNBCDV ( TEMP, BCD, NDS)
      CALL RITE2V ( 922, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1,  9, -1, 9H  PLOTTED, IERR)
      TEMP = NREV
      CALL BNBCDV ( TEMP, BCD, NDS)
      CALL RITE2V ( 922, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      IH = IH - IDEL
      CALL RITE2V ( ILF, IH, MAR, 90, 1, 18, -1, 18HAVERAGE PRESSURE -,
     1                                                  IERR)
      IH = IH - IDEL
      CALL BNBCDV ( APRES, BCD, NDS)
      CALL RITE2V ( 826, IH, MAR, 90, 1, NDS, 1, BCD, IERR)
      RETURN
      END

745 WORDS OF MEMORY USED BY THIS COMPILATION
```